· ENGINEERING NEWS-RECORD ·
OCTOBER 6, 1938

THE WEEK'S EVENTS

Tornados Damage Charleston Buildings

Modern structures are uninjured but many old brick buildings fail in storm

A major tornado drove a 1,600-ft. wide path for about a mile across the tip of the Charleston peninsula on the morning of Sept. 29. At the same time a smaller storm 400-ft. wide damaged summer cottages on Sullivan's Island, about ten miles north of the city, and another struck the west side of Charleston near the Ashley River bridge.

The office of the Harza Engineering Co., consulting engineers for the Santee-Cooper power and navigation project, was directly in the path of the storm but suffered no major damage. This report was prepared from notes made by H. G. Gerdes of the Harza staff.

Damage from the storm is estimated at several millions, and about 26 people were killed. Destruction of power and telephone lines by falling trees and poles left the city temporarily in darkness.

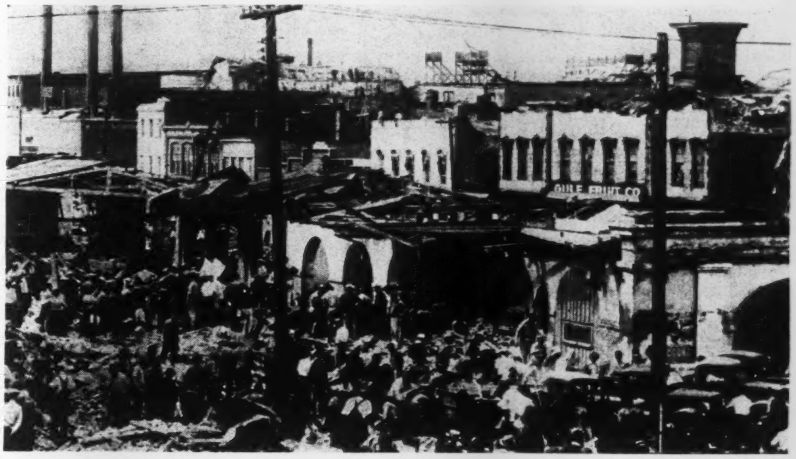
Old buildings injured

Severe structural damage in the storm area was confined to about 20 or 30 buildings, mostly old structures with brick walls and wooden framing. The greatest amount of damage appeared to have been done by suction of the wind, roofs and walls being pulled up and out. An eyewitness described one old brick building as exploding; the roof and wooden interiors were sucked loose, and the floors and brick walls collapsed together into a pile of debris.

Part of the roof sheathing and purlins were pulled off St. Michael's Church, built in 1761. The city hall, built in 1801, suffered damage to doors and windows but did not sustain any major structural damage.

Part of the fourth floor of the Timrod Hotel, of frame construction, was demolished, but the lower three stories, of brick, were not injured.

The three-story brick plant of the Charleston Paper Co. was completely demolished, killing several people. A one-story brick warehouse and an old two-story brick house were destroyed; in the latter several people were killed.



Wide World Photo

Ruins of the Charleston Wholesale Paper Co., destroyed by the tornado at Charleston, S. C. Nine people were killed in the wreck of this building.

Some Work Resumed At Fort Peck Dam

Construction work at the Fort Peck Dam is being carried on under altered plans as a result of the slide which occurred in the upstream face of the dam on Sept. 22. The dredges Jefferson and Madison have been shut down awaiting further study of the damage to the fill, but the dredge Gallatin is placing fill in the dike section west of the main dam, and the dredge Missouri is placing material in the berm at the downstream toe.

Placing of quarry stone on the upstream face of the dam was interrupted when the earth movement carried away several sections of railroad track. A new track, however has been laid on the downstream face of the dam to permit moving the quarry stone to the upstream side. This new track joins the present railroad at the east abutment of the dam and rises across the downstream face to the west abutment; there it crosses the crest of the dam and connects to the track on the upstream side. Quarry stones, which continued to arrive during construction of the new railroad line, was stock-piled at the base of the dam.

Some of the equipment buried during the earth movement has been located, and salvage operations have been started.

Federal Contractors Held Exempt from Licensing

A general contractor performing work exclusively on federal property in erecting a public building is not required to obtain an Alabama contractor's license, according to a ruling of Attorney-General A. A. Carmichael of Alabama.

Whether a contractor working on federal property on a project other than a public building must qualify for a license, the ruling said, "depends upon what jurisdiction the state has ceded in the land in question to the federal government."

PWA Applications Exceed Funds

PWA reached the Sept. 30 deadline for receipt of applications for grants with 12,804 requests in its files, which it had received in a period of 101 days. Only about half of these can be granted with the funds on hand. Allotments will continue for about two weeks more.

On Oct. 4 grants of $593,784,000 had been approved for 5,715 projects. It is expected that $50,000,000 more will be granted.

Parkway Substituted For Battery Tunnel

New York receives $12,000,000 for circumferential parkway around Brooklyn and Queens

PWA has turned down New York City's application for a $12,000,000 grant for a proposed vehicle tunnel connecting the Battery, at the foot of Manhattan Island, with Brooklyn. The city, however, will receive a $12,000,000 grant as PWA's contribution toward a $27,900,000 circumferential parkway circling the boroughs of Brooklyn and Queens on Long Island.

In order to obtain this large grant, the city asked that certain previously approved projects be rescinded and the funds be diverted instead to this one undertaking. A group of projects to be rescinded was selected by New York City officials on which it appeared likely that construction could not be started in time to meet the deadline of Jan. 1. The allotments for the projects rescinded total $7,602,000, and new funds were added to this amount to make up the $12,000,000 grant.

The new parkway will run from Owls Head Park in Brooklyn to connect with a completed parkway at Fort Hamilton. From the east end of the completed parkway the new construction will connect with Emmons Ave. and from the east end of that avenue will continue to the west end of the completed Laurelton Parkway. From the east end of Laurelton Parkway, the new project will continue in a northwest direction to meet the approaches of the Bronx-Whitestone bridge.

The total length of new parkway construction is about 39 miles. The pavement on grade will consist of two separated strips of concrete, each 23 ft. wide, so located that an additional lane in each direction can be added at a future time. Grade crossings will be eliminated by means of about 70 bridges, with access drives at important intersections. The bridges will be wide enough to carry three lanes of traffic in each direction.

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Missouri Building Body Begins to Disband

Four officials of the Missouri State Building Commission were laid off Sept. 26 as part of a general cost reduction program. The $17,000,000 state building program upon which the commission has been engaged is nearly completed, with only finishing touches on a few buildings remaining.

Officials dismissed are L. R. Bowen, supervising architect; A. H. Kendrick, general superintendent of construction; George E. McIntyre, assistant consulting engineer, and B. F. Cook, mechanical engineer. Bowen will continue to serve through October, and the other dismissals are effective Oct. 1.

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Carquinez Bridge Owner Must Refund Tolls

The California Supreme Court on Sept. 27 upheld an order handed down last February by the California Railroad Commission reducing the tolls on the Carquinez Bridge from 60 cents per car and 10 cents per passenger to 45 cents per car and 5 cents per passenger.

When the American Toll Bridge Co., owners of the bridge, appealed the commission's decision to the state court, the court ordered the difference between the new and old tolls impounded. The bridge operators have since been taking names and addresses of persons paying the toll, and, unless an appeal is made to the U. S. Supreme Court, the operators will have to refund about $155,000 to motorists.

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Flood Control Planned In New England

Army and FPC recommend expenditure of $11,000,000 during this fiscal year on flood control

Upon receiving a joint report from the Corps of Engineers, the Federal Power Commission and the PWA, that $11,000,000 could profitably be spent during the balance of the current fiscal year on flood control projects in New England, President Roosevelt today directed a budget bureau survey to determine how and from what sources this amount could be procured so as to make possible the immediate start of construction.

The Corps of Engineers has a $4,000,000 reserve fund in its annual appropriation that could be used, but the balance of the money would necessarily come from some other source, such as PWA or WPA.

The report suggests an immediate start on the following projects: Connecticut River reservoirs at Union Village, Vt., Surrey Mountain, N. H., and Knightville and Birch Hill, Mass. Connecticut River local protective works at Hartford, East Hartford, Springfield, West Springfield, Chicopee, Holyoke and Northampton. Merrimack River reservoirs at Franklin Falls and River Hill, N. H. It is believed that some means will be found to finance these projects immediately.

Cement Purchase Plan is Dropped

Plan for central purchasing of all federally-used cement largely abandoned

After six months of experimentation with its plan to centralize all portland cement purchases by the various agencies of the federal government, the administration has quietly abandoned the whole idea. No official announcement has been made, but the Army has resumed its old practice of buying cement for large projects through its district offices, and the Interior Department, the other major federal construction agency, has received a blanket clearance to handle its own contracts for standard portland cement. The Bureau of Reclamation, however, will continue for the time being to purchase special cements, but only those through Procurement Division of the Treasury.

As originally envisioned, the administration plan was to get prices f.o.b. a large number of mills in all sections of the country and to fulfill government cement needs, as they arose, by ordering from that mill which offered the lowest f.o.b. price plus delivery cost. This plan broke down when a large proportion of the industry refused to bid on indefinite quantities.

The next step was to take bids on an f.o.b. mill basis for definite quantities, making a separate transaction out of the fulfillment of each requisition. This plan worked in the West, but in the East it was still impossible to get any bids. The plan was too cumbersome, moreover, to be utilized except in the case of unusually large projects, such as the Grand Coulee Dam.

In the case of smaller undertakings it was customary to grant special exemptions permitting the federal agency concerned to buy directly, without advertising through the Procurement Division. As time passed the tendency was to exempt larger and larger projects, until the exception became the rule and it was finally decided to drop the centralized purchasing plan altogether.

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Governor Proposes Increase In Virginia Road Body

Governor Price of Virginia has suggested that the membership of the Virginia State Highway Commission be increased from five members to seven or nine. The governor made the suggestion to a newly created legislative committee which was appointed to study the primary and secondary systems of highways in Virginia and to report to the 1940 session of the legislature.

WASHINGTON HIGHLIGHTS

Special reports by Paul Wooton

PROTECTION of a residential area against deterioration of property values is the objective of an experiment being initiated in Baltimore. The first step in this movement, which is sponsored by the Baltimore Housing Authority, will be a condition survey of the area by the WPA, covering about 1,600 homes within a 50-block area. This will determine which units are sub-standard and what repairs are needed to restore values.

Thereafter the owners will be canvassed in an effort to promote immediate repairs, stressing the value of maintaining the character of the neighborhood. Financial assistance in making repairs will be offered by private lenders and by such federal agencies as the Home Owners Loan Corporation. The city has promised to cooperate by speeding up needed street, park and playground improvements.

THE INTERSTATE Commerce Commission has denied the application of Roy Greene, acting as an individual promotor, for permission to build a new railroad between Pittsburgh and Harrisburg, Pa., along the right-of-way of the long-abandoned South Penn R.R. The plan was opposed by four existing railroads, by the Pennsylvania Public Utility Commission, and by the Pennsylvania Turnpike Commission, which intends to construct a toll highway along the same route.

Testimony before the commission disclosed that the applicant, an electrical engineer employed by WPA, has no financial backing (intending to finance construction through an RFC loan); has no plan for obtaining control of the right-of-way; and has made only a perfunctory inspection of a small portion of the route; has made no serious study of the probable costs of construction and operation, and has made no plans for securing adequate terminal facilities.

ORAL ARGUMENT on the suit of a group of utility companies in the TVA area to test the validity of the TVA Act, originally scheduled for Oct. 19, has been postponed until Nov. 14. This step was taken by the U. S. Supreme Court at the request of both parties to the suit because John Lord O'Brian, counsel for TVA, is the Republican candidate for Senator from New York.

JAMES C. IRWIN

Irwin Retires from B&A

James C. Irwin retired on Sept. 30 from the post of valuation engineer of the Boston & Albany Railroad which he had held since 1914.

After his graduation in 1891 from the University of Pennsylvania, Irwin spent a year teaching and then entered the service of the New York Central and Hudson River R.R. as superintendent of signals on the Mohawk Division. He later became signal engineer of the New York Central system, and during the electrification of the New York suburban zones he was superintendent of construction and later resident engineer on the Grand Central Terminal. Then, before joining the B&A, Irwin spent several years as chief engineer of the Rutland R.R.

Last spring, Irwin completed a term as president of the American Railway Engineering Association. He is a life member and is a member of the board of directors of that body, and for six years has represented the Association of American Railroads on the Standards Council of the American Standards Association.

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RFC Approves Loan For Narrows Bridge

Word has been received by Highway Director L. V. Murrow of Washington that RFC has approved a loan to finance the state's share of a toll bridge across the Narrows near Tacoma. PWA has made a grant of $2,700,000.

The low bid on the bridge, when proposals were opened last week, was offered jointly by the Pacific Bridge Co. of San Francisco, the General Construction Co. of Seattle, and the Columbia Construction Co. of Bonneville. Their bid was $5,950,000.

Most USHA Money Is Allocated

Straus says subsidy provisions in housing act limit available money to $650,000,000

With more than a half billion dollars of the U. S. Housing Authority's loan fund allocated, formally or informally, to local authorities, USHA Administrator Nathan Straus announced on Sept. 29 that all funds available for loans to local housing authorities will probably be committed by Dec. 1.

Definite contracts for loans to local authorities have been approved which total $202,807,000. An additional $370,960,000 has been earmarked for specific communities. These earmarkings do not constitute contracts; they give communities an idea of how much they can expect, and are conditional upon the local authority carrying out the steps necessary to entitle itself to a definite loan contract.

Although the housing act authorizes USHA to make loans of $800,000,000 over the next three years, Straus points out that "There is a limitation of $28,000,000 on the total amount of annual contribution contracts which the USHA can make. As a practical matter, this limitation on the amount of the annual contribution contracts means that the total amount which the USHA can now earmark for 90 per cent loans will be $650,000,000."

Straus' statement was made in connection with the announcement that an additional $54,630,000 had been earmarked for 18 local housing authorities. This included earmarkings additional to previous commitments for the cities of Louisville and New Orleans, which each received $5,000,000 additional; Philadelphia, which is assigned $10,000,000; and San Antonio, for which an additional $3,600,000 has been earmarked.

The remainder of the new earmarkings was for fourteen housing authorities which have not previously participated in the program. The largest sum involved was $8,000,000, earmarked for the Puerto Rico housing authority. Puerto Rico received an additional $3,000,000 which was earmarked for the housing authority of San Juan.

Three Connecticut cities — New Haven, New Britain and Waterbury — were allocated $5,500,000, $1,500,000 and $1,000,000, respectively. These earmarkings are conditional on a change in the Connecticut housing authority law to authorize the sale of bonds of housing authorities to private investors or on the cities for which projects are contemplated agreeing to donate or loan 10 per cent of the cost.

Public Health Authority Dies in Richmond

Dr. Ernest C. Levy, until recently director of public welfare in Richmond, Va., and for many years chief health officer there, died Sept. 29 in Richmond at the age of 70.

Dr. Levy graduated from the Medical College of Virginia in 1890 and practiced in Richmond for several years. In 1899 he undertook special bacteriological studies of the water supply of the city of Richmond and after that time engaged exclusively in public health work. He became city bacteriologist of Richmond in 1906 and a few months later was made chief health officer of the city, a position he held until 1918. Then, after a few months service in the Medical Corps of the army, he became director of public welfare.

George P. Morrill, connected for many years with The Raymond Concrete Pile Co., died in Bridgeport, Conn., Sept. 29 at the age of 65. A graduate of the Sheffield Scientific School in 1897, Morrill had done engineering work in Japan, the Philippine Islands, and Cuba, as well as in this country and in Canada.

Adam Ritter, retired assistant architect of the Southern Railway System, died in Cincinnati Sept. 29 aged 67.

Joseph E. Murphy, civil engineer and writer, died in Denver recently at the age of 69. Recently employed by the city of Denver, Murphy was formerly an editor of *Popular Mechanics.*

Wade Moses, 37, formerly an engineer for the city of Cleveland, died there Sept. 21.

Joseph V. Little, for the past year technical adviser for the Firth Sterling Steel Co., died in Bala, Pa., Sept. 27 at the age of 70. Little was for more than 40 years a member of the steel distributing firm of MacFarland & Little. The concern was dissolved about a year ago after the death of MacFarland, and Little took his position with the Firth Sterling Co.

Austin Burt, city manager of Ontario, Calif., died Sept. 25 at the age of 67. Burt was educated at the University of Minnesota and at Cornell University, graduating from the latter in civil engineering. He was for 30 years manager of public service utilities at Cedar Falls and Waterloo, Iowa, and went to Ontario about ten years ago.

Frank W. Jennings, who practiced civil engineering in Columbus as a member of the Jennings-Lawrence Co., died there Sept. 28 at the age of 70. Jennings studied for a year and a half at Ohio State University and then in 1885 went to work for the Hocking Valley R.R. He worked for various railroad companies, rising to the rank of assistant chief engineer, until 1903, when he entered private practice.

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Consultants Will Manage Knoxville Utility

Because the City of Knoxville, Tenn., has not been granted legislative authority to organize a utility board to manage its newly acquired electric distribution system, the designing and construction firm of Burns & McDonnell, engineers for the city, have been required to operate the utility. This arrangement is temporary, until the city is legally able to organize a utility board.

LABOR NOTES

A STRIKE was called by the hoisting engineers on the Grand River Dam project in Oklahoma Sept. 2[illegible]. Other trades walked out in sympathy with the engineers. The objective of the strike is a closed shop and preferential employment of Oklahoma workmen. The contractor rejects the closed shop demand and insists on the right to bring in the force of key men from outside.

A JURISDICTIONAL strike has held up construction of the Pennsylvania Finance Building in Harrisburg, being erected by McCloskey & Co. of Philadelphia. The dispute, between carpenters and ironworkers, concerns the hanging of metal doors.

ANOTHER jurisdictional strike in Illinois has tied up much large construction work in and around Springfield. Both building laborers and ironworkers claim the right to handle reinforcing steel for concrete work.

THE TVA WAGE SCALE will not be used by the South Carolina Public Service Authority in building the $37,500,000 Santee-Cooper canal and hydroelectric project. The scale to be used provides a minimum of $.40 an hour for unskilled workers as compared with $.47½ under the TVA scale. The authority announced it had adopted the lower scale with regret but that the project cannot be built within the allotted amount of money if the higher scale is used.

News continued on adv. page 38

ENGINEERING CONSTRUCTION CONTRACTS REPORTED BY ENGINEERING NEWS-RECORD, IN SEPTEMBER, 1938

Engineering News-Record *reports projects of the following minimum costs: Waterworks, excavation, drainage and irrigation,* $15,000; *other public works,* $25,000; *industrial buildings,* $40,000; *other buildings,* $150,000.

Five Weeks—Thousands of Dollars (000 Omitted)

	New England	Middle Atlantic	South	Mid West	West of Mississippi	Far West	United States Sept. 1938	United States Nine Months 1938	United States Nine Months 1937	Canada
Public Works										
Waterworks	508	1,442	1,585	3,155	1,445	1,129	**9,264**	83,522	56,928	113
Sewerage	952	2,496	1,308	3,651	2,392	1,676	**12,475**	80,915	76,274	25
Bridges, public	1,191	3,236	1,562	2,559	1,036	2,601	**12,185**	80,537	95,838	190
Earthwork and waterways	860	5,154	1,371	1,574	1,849	4,326	**15,134**	207,327	82,243	784
Streets and roads	3,282	18,497	9,358	27,908	23,634	6,814	**89,493**	486,604	320,276	1,118
Buildings, public	6,935	28,101	5,707	8,150	7,850	11,753	**68,496**	278,866	244,192	538
Unclassified, public	631	18,297	1,653	2,042	3,464	3,149	**29,236**	144,674	115,833	1,334
Total public	**14,359**	**77,223**	**22,544**	**49,039**	**41,670**	**31,448**	**236,283**	**1,362,445**	**991,584**	**4,102**
Federal government (included in above classifications)	3,432	5,317	4,446	4,001	4,311	15,232	**36,739**	261,960	161,106	......
Private										
Bridges, private	....	933	....	....	....	25	**958**	5,551	6,549	......
Buildings, industrial	435	4,917	1,447	1,668	1,075	747	**10,289**	115,742	406,580	1,340
Buildings, commercial	1,817	24,820	2,225	3,325	1,407	2,214	**35,808**	455,658	351,172	773
Unclassified, private	225	895	968	1,594	2,319	386	**6,387**	64,864	130,123	......
Total private	**2,477**	**31,565**	**4,640**	**6,587**	**4,801**	**3,372**	**53,442**	**641,815**	**894,424**	**2,113**
Total Engineering Construction										
September, 1938 (5 weeks)	**16,836**	**108,788**	**27,184**	**55,626**	**46,471**	**34,820**	**289,725**	....	....	6,215
August, 1938 (4 weeks)	14,500	79,640	27,726	25,814	51,610	36,981	**236,271**	....	....	[illegible],253
September, 1937 (5 weeks)	10,078	68,614	24,623	44,778	41,784	20,634	**210,511**	....	....	9,172
Nine months, 1938	95,258	790,874	193,889	264,909	346,093	313,237	....	2,004,260	....	63,479
Nine months, 1937	90,057	829,964	186,750	314,534	273,991	190,712	....	....	1,886,008	102,786

CONTRACTS AND CAPITAL

ENR CONSTRUCTION VOLUME AND NEW CAPITAL . . . FHA MORTGAGES

(,000 omitted)	September 1937 (5 wks.)	September 1938 (5 wks.)	% Change	Nine Months 1937 (39 wks.)	Nine Months 1938 (39 wks.)	% Change
Total Construction Volume.....	$210,511	$289,725	+38.0	$1,886,008	$2,004,260	+6.3
Private..................	84,566	53,442	−37.0	895,424	641,815	−28.0
Public..................	125,945	236,283	+88.0	991,584	1,362,445	+37.0
Federal..................	26,774	36,739	+37.0	161,106	261,960	+62.0
Total New Productive Capital..	$688,922	$374,009	−46.0	$2,014,905	$3,112,868	+54.5
Private Investment..........	92,529	122,624	+33.0	860,617	773,171	−10.0
Federal (non-federal work).....	111,227	256,209	+130.0	408,065	1,200,579	+194.0
Federal (federal work).........	485,166	−4,824	......	746,223	1,139,118	+53.0
FHA Mortgages Selected for Appraisal...............	$45,319	$109,314*	+142.0	$474,960	$761,923*	+61.0

*Preliminary totals.

CONSTRUCTION COSTS . . . WAGE RATES . . . PRICES

	October 1937	October 1938	% Change	Change September to October 1937 Sept.	1937 Oct.	%	1938 Sept.	1938 Oct.	%
ENR Construction Cost Index, 1913 = 100.......	241.90	234.30	−3.0	241.62	241.90	+0.1	232.70	234.30	+0.7
ENR Building Cost Index, 1913 = 100............	201.00	195.48	−2.8	200.62	201.00	+0.2	194.80	195.48	+0.3

ENR 20-CITIES' AVERAGE

	October 1937	October 1938	% Change	1937 Sept.	1937 Oct.	%	1938 Sept.	1938 Oct.	%
Common Labor...........	$0.676	$0.682	+0.9	$0.673	$0.676	+0.4	$0.677	$0.682	+0.7
Skilled Labor (Av. 3 Trades)	1.378	1.427	+3.6	1.369	1.378	+0.7	1.426	1.427	+0.1
Bricklayers...............	1.467	1.514	+3.2	1.459	1.467	+0.5	1.519	1.514	−0.3
Struct. Ironworkers........	1.425	1.479	+3.8	1.413	1.425	+0.8	1.473	1.479	+0.4
Carpenters................	1.242	1.288	+3.7	1.235	1.242	+0.6	1.288	1.288	0
Cement, per bbl...........	$2.53	$2.57	+1.6	$2.53	$2.53	0	$2.57	$2.57	0
Reinforcing Steel, cwt......	2.91	2.50	−14.1	2.91	2.91	0	2.48	2.50	+0.8
Struct. Steel Shapes, Pitts..	2.25	2.10	−6.7	2.25	2.25	0	2.10	2.10	0
Sand, per ton.............	1.22	1.24	+1.6	1.16	1.22	+5.2	1.24	1.24	0
Lumber, 2x4 Fir, per M ft...	37.02	32.40	−12.4	37.23	37.02	−0.6	31.49	32.40	+2.9
Lumber, 2x4 Pine, per M ft.	32.60	28.39	−12.9	32.93	32.60	−1.0	28.15	28.39	+0.9
Brick, common, per M.....	14.23	13.81	−3.0	14.33	14.23	−0.7	13.86	13.81	−0.4
Ready-Mixed Concrete, c.y.	7.42	7.12	−4.0	7.38	7.42	+0.5	7.12	7.12	0
Struct. Clay Tile 3x12x12...	72.85	74.24	+1.9	72.85	72.85	0	74.24	74.24	0
Paving Asphalt, cars, ton...	17.15	14.85	−13.4	17.15	17.15	0	15.44	14.85	−3.8

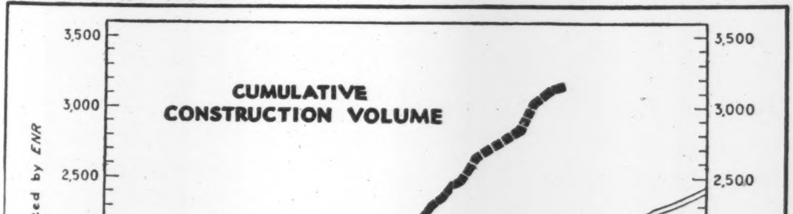
MATERIAL SHIPMENTS . . . BUILDING PERMITS

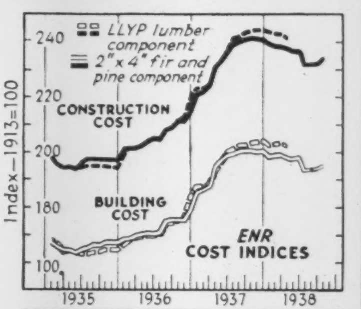
	September 1937	September 1938	% Change	Aug. 1938	% Change Aug.-Sept.
Lumber (% 1929 wk. av.) NLMA............	65.6	64.8	−1.2	66.3	−2.3
Steel (% operating capacity) AISI	77.3	44.6	−42.2	40.6	+9.8

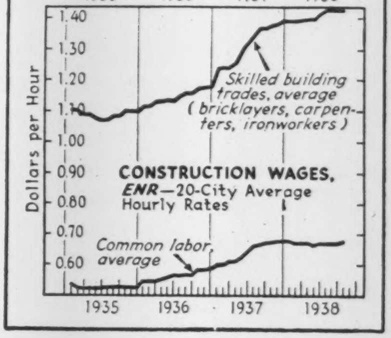
	August 1937	August 1938	% Change	Eight Months 1937	Eight Months 1938	% Change
Fabricated Struct. Steel (AISC) Tons.	166,095	91,923	−44.7	1,102,554	740,455	−32.8
Cement, thous. bbl. (USB of M)....	12,291	11,823	−3.8	77,066	67,512	−12.4
Building Permits, Dun & Bradstreet (,000 omitted).................	$87,584	$100.733	+15.0	$765,101	$769,097	+0.5

RENT INDEX . . . EMPLOYMENT

	August 1937	August 1938	% Change	July 1938	% Change July-Aug.
Rent (Housing) Index, NICB................	87.8	86.6	−1.4	86.6	0
Trade Unions, % Employed, AFL............	88.0	83.0	−5.7	82.0	+1.2
Building Trades, % Employed, AFL..........	78.0	66.0	−15.4	65.0	+1.5







THIS WEEK'S FIGURES

(Thousands of dollars)

CONTRACTS

	Week Ending Oct. 7 1937	Week Ending Sept. 29 1938	Week Ending Oct. 6 1938
Federal	$4,048	$4,297	$11,197
State & Municipal	19,393	35,811	41,503
Total public ..	$23,441	$40,108	$52,700
Total private ..	25,389	9,121	15,254
TOTALS	$48,830	$49,229	$67,954

Cumulative
1938 (40 weeks)....$2,072,214
1937 (40 weeks)....$1,934,838

Note: Minimum size projects included are: Waterworks and waterways projects, $15,000; other public works, $25,000; industrial buildings, $40,000; other buildings, $150,000.

NEW PRODUCTIVE CAPITAL

	Cumulative 1937 40 Wk.	Cumulative 1938 40 Wk.
NON-FEDERAL	$1,287,023	$2,026,862
State & Mun. bonds	410,311	459,865
Corporate securities	468,447	332,077
PWA loans, grants.	178,126	681,664
RFC loans........	29,939	97,391
U.S.H.A. loans.....	......	202,807
R.E.A. loans.......	......	51,558
Federal Aid-Highways	200,000	201,500
FEDERAL	$746,223	$1,136,704
TOTAL CAPITAL..	$2,033,246	$3,163,566

ENR INDEX NUMBERS

Base = 100	Construction Cost 1913	Construction Cost 1926	Building Cost '13	Building Cost '26	Volume '13	Volume '26
Oct., 1938..	234.30	112.63	195.48	105.67	...	...
Sept., 1938.	232.70	111.86	194.80	105.30	213	93
Aug., 1938.	232.39	111.71	194.49	105.14	218	96
Oct., 1937..	241.90	116.10	201.00	108.70	167	73
Sept., 1937.	241.62	115.85	200.62	108.53	150	66
1937 (Av.).	234.71	112.66	196.15	106.07	172	75
1936 (Av.).	206.42	99.15	172.18	93.14	185	81
1935 (Av.).	196.44	94.43	165.76	89.65	134	59

ENGINEERING NEWS-RECORD

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Volume 121, Number 14

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Editorial Offices at 330 West 42nd Street, New York

OCTOBER 6, 1938

STORM HAVOC along the shores and beaches of southern New England in the hurricane of Sept. 21 is now known to be very much more serious than earlier reports indicated. No similar coastal destruction seems to be on record since earliest settlement. Not only were houses on exposed beaches swept away almost without exception, but beaches and spits were breached by inlets, land was eroded, and great stretches of shoreline were shown to be vulnerable to storm attack. That extensive change in occupancy and control of the shores is imperative can hardly be questioned in view of these effects; but it is less certain that the present lesson alone will be able to bring about action. Connecticut and Rhode Island, worst hit both because of direct storm exposure and because of coincidence of storm tide and normal flood tide, have most reason to act at once in controlling their waterfront. By immediate prohibition of rebuilding on dangerous shores and then organizing a thorough study of beach conditions and proper protective policy, they can turn the storm destruction to practical value.

One Useful Result

AS PARTIAL OFFSET to its ruthless destruction of life and property the New England hurricane put an end to a great many old and obsolete small bridges on the highway system. In this part of its work it did the region a good turn, for like most other sections of the country New England is amazingly backward in modernization of minor road bridges. Those destroyed by the hurricane will now be replaced by modern structures—strong enough for present and future loads and, it is to be hoped, of ample width and so located as to suit both present and future road locations. An observant New England engineer remarked with some satisfaction, "Another flood storm like this one and our obsolete small bridges and ancient dams will all be gone." By the same token many states west of the Hudson might welcome a similar flood visitation; but general devastation would be a high price to pay for the gain. Better to tackle the bridge problem direct and modernize without waiting for a great storm to compel action.

More Complete Control

FAILURE of a number of small dams in New England during heavy storms within less than three months adds new emphasis to the need for thorough and continuing supervision of dams by a state body which has power to require needed changes or reconstruction. Some states require that plans for new dams be approved by the state engineer or a state board and a few have laws giving the state engineer authority over existing dams, but generally the condition of old dams, and especially of the many small dams, is nobody's business. New England has hundreds of old dams of no great size but still sufficiently large and so placed as to be a menace to a considerable number of people and their property. Even some of the newer dams like the one at Killingworth, Conn., were built with spillways inadequate for the flood flows they had to pass. In states where adequate laws are lacking, engineering organizations should cooperate with state engineer officers in pressing for more complete control over the construction and maintenance of dams.

Reciprocal Licensing

DIFFICULTY over reciprocal licensing has risen between the engineer licensing boards of Oregon and California. Oregon has refused to grant licenses to registered engineers from California without examination on the ground that California has refused like privileges to Oregon licensees. On its side the California board maintains that it has set up no such general prohibition but has refused only in the case of applicants who, failing to meet Californian requirements, have gone to Oregon for a license and then have returned to California demanding reciprocal recognition. Obviously the California board cannot be expected to grant reciprocal privileges under such circumstances, and the possibility of such attempts to sidestep the high requirements of one state by obtaining a license in one having less strict requirements raises question as to the soundness of the whole idea of reciprocal action. The legality of reciprocity has long been questioned in some states. This new complication brings the whole matter into new light and calls for special action by the National Council of State Boards of Engineering Examiners at the council's coming meeting.

Questionable Commitments

TWELVE MILLION DOLLARS of PWA money is to to go toward building a circumferential highway in Brooklyn instead of toward starting the $70,000,000 vehicle tunnel that was planned between Brooklyn and Manhattan Island at the Battery, according to a decision made last week. This decision is wise, chiefly because the money can be put to work quickly and the work can be attacked at many points at one time, which is the main objective of the PWA program. The Battery tunnel could not be started quickly, would require four years to build and would commit the city to an enormous expenditure for a traffic artery whose economic justification has not been clearly demonstrated. At the Lincoln tunnel, only a few miles away, all work on the north tube not yet let to contract has been stopped due to the small amount of traffic using the south tube. In the light of this experience New York should not start an even more costly project without the fullest showing that it will pay its way.

Public Relations

WITH THIS ISSUE *Engineering News-Record* presents to its readers a discussion of the importance of public relations to American industry. It is part of a general presentation on this subject being made by all McGraw-Hill publications in order to concentrate widespread attention on a subject that now appears to be of utmost importance to the economic, social and business betterment of the country. The presentation is in two parts, the first a general exposition of reasons why industry needs to develop better public relations, the second directed toward the situation of the construction industry.

The public-relations problems of construction are unlike those of most other industries in that construction is essentially a service—not an agency for producing a commodity that seeks a buyer but one to supply a product according to the buyer's specification. Construction flourishes or wanes as the demand for its services rises or falls. Hence its continued prosperity rests not alone on the quality of its services but also on a sustained demand.

In the past, construction has been content to sit back and wait for the buyer to come seeking its service. It has failed to recognize two important facts: first, that general business prosperity—the very condition that makes for good business in construction—is in itself largely dependent on the work that construction creates in mine, mill and factory; and second, that if these two interrelated factors are to be kept moving ahead steadily the construction industry must do its part by consistently and regularly keeping the public informed of the value and importance to general prosperity of the multitude of structures which it creates and the vast amount of direct and indirect employment which it gives.

Here then is the key to the presentation of the subject of better public relations for the construction industry as it will be found in this issue. Major emphasis is placed on the magnitude of construction, the diversity of its operations, the importance of the structures which it builds, and the extent and variety of the employment which it creates. If the industry is to sell itself to the public it must first know these facts and figures and recognize their true significance.

These are the starting points of a public relations program. Around them must be built the complete program, including such vital subjects as employee relations. To the more complete development of these elements of the program this journal expects to devote a considerable amount of attention in the coming months.

Opportunity at Hand

ANNOUNCEMENT last week that the Associated General Contractors and the American Road Builders Association will hold simultaneous conventions and a joint exhibit of construction equipment in San Francisco March 5 to 11, 1939, is of outstanding interest. With the National Asphalt Conference of the Asphalt Institute holding its highway meeting at Los Angeles only a week before the San Francisco conventions the Pacific Coast becomes the convention Mecca of the construction industry in the early months of next year.

It would be encouraging to feel that this grouping was not wholly due to special circumstances; that it represented a growing sense of the unity of the construction industry and the need for concerted action in solving the problems that the industry faces.

Working separately, no component element of the industry can go far toward stabilizing construction. It was this conviction that inspired the score of organizations that met in a highway and building congress at Detroit six years ago to draft a plan for business recovery and lay a foundation for continued unity of action. The plan died of inanition. There was no one to foster the child of progress, and its godfathers promptly forgot its christening.

Today the need for a united construction industry is even greater than it was six years ago, in the early gloom of business depression. The problems ahead have grown larger rather than smaller. Construction united in purpose and action can redeem itself from its present deflation attitude; it can bring about the reeducation of the people to its opportunities and responsibilities.

Will the conventions and joint construction equipment exhibit in San Francisco in March be a compelling force for unity? They can be. They represent all the elements of the construction industry more widely than do any equal number of organized units of that industry. It may be hoped that they will see their opportunity.

Northeastern Gale and Flood

Hurricane out of normal path wrecks Long Island and New England shores and continues inland to flood New England rivers and devastate forests

IN AN UNPRECEDENTED fashion and with unexampled results, a tropical hurricane on Sept. 21 passed over Long Island and on into New England to provide this heavily populated region with the worst disaster in its history. Never in property damage and only twice in lives lost has any hurricane in this country taken such a toll as did this storm. Because of widespread breakdown of communications—telephone, radio, railways and highways—information on the extent of the damage has been assembled only with difficulty. Even now official agencies have only "preliminary" reports.

In the accounts which follow two distinct aspects of the storm are recognized—shore damage by wind and high tide and river damage by flood in the interior. Of fundamental engineering significance in the former is the possible combination of high tides and wind that can pile waves into the hearts of some of our seaboard cities. And in so far as river floods are concerned, there is the demonstration of bankfull streams having superimposed on them runoff from a rain of 6-in. intensity in 24 hours. The 1938 storm, in both of these aspects, was of major technical importance.

Water and Wind on the Shore

H. W. RICHARDSON

Associate Editor, *Engineering News-Record*

THE devastation and destruction wrought by the tropical hurricane that struck the Southern New England coast line on Sept. 21 is revealed by an inspection of the area as even greater than first reports indicated. From Bridgeport, Conn., on the west to Hyannis, Mass., on the east, a coastal stretch 150 miles long bore the brunt of the storm's attack, though the full fury of the hurricane was centered in the 50-mile reach between New London, Conn., and Newport, R. I. West and east of these points the intensity of the storm diminished, though some local spots such as Madison and Saybrook, Conn., and Wood's Hole, Mass., suffered damage out of proportion to that of surrounding areas.

Reliable reports place the sustained wind velocity along the shore from 85 to 100 m.p.h., with occasional gusts estimated at 50 per cent higher. This high wind piled up the seawater coincident with a high tide, to produce a storm tide averaging 10 ft. higher than mean high water.

Communication and transportation facilities were wrecked by the storm, complicating the rescue and rehabilitation work.

The death toll stands close to 500, and threescore persons are still missing. Property damage has been estimated at a minimum of $200,000,000, but even an approximate true figure is impossible to compile. The greatest loss was direct damage to shorefront property and that in communities bordering on harbors and bays, such as New London and Providence; next was that of utilities—the telephone and power companies—whose service lines and poles were reduced to mile upon mile of tangled skeins; and last, yet high in the list of property damage, is the loss of thousands of boats, barges, tugs and lighters.

A detailed account of a personal inspection of several shore communities follows.

New London

At New London, a seaport at the mouth of the Thames River, hundreds of craft of all kinds were swept out of the harbor and piled up on shore, adding to the destruction of shorefront property. The U. S. Lighthouse Service tender "Tulip" was blown onto the main line tracks of the New Haven Railroad, its steel prow coming to rest on the eastbound track, its stern left high and dry far from the shoreline.

Communication and power lines went out as trees and poles were toppled by the wind. Passage through the streets became impossible because of fallen trees and wind-borne debris. Whole roofs of warehouses and mills dropped into streets already filled with wreckage. Then a fire broke out, adding to the terror. Starting in a warehouse on Bank St., along the railroad and two blocks west of the main business center, the wind-fannel conflagration quickly enveloped three city blocks.

Details of the storm's happening and resulting damage were obtained by interview with city engineer George Watters, building inspector Wm. Gunn, and Ralph DeSimone, genial but haggard general manager of the Merritt-Chapman & Scott Corporation's New London base.

A rainfall of 0.97 in. on Sept. 19, 2.83 in. on the 20th and 6.50 in. on the day of the hurricane, Sept. 21, had already caused flooding of parts of the city. Failure of power shortly after the wind started at 2 p.m., combined with flooding, shut down the water pumping plant that serves about one-third of the city and the

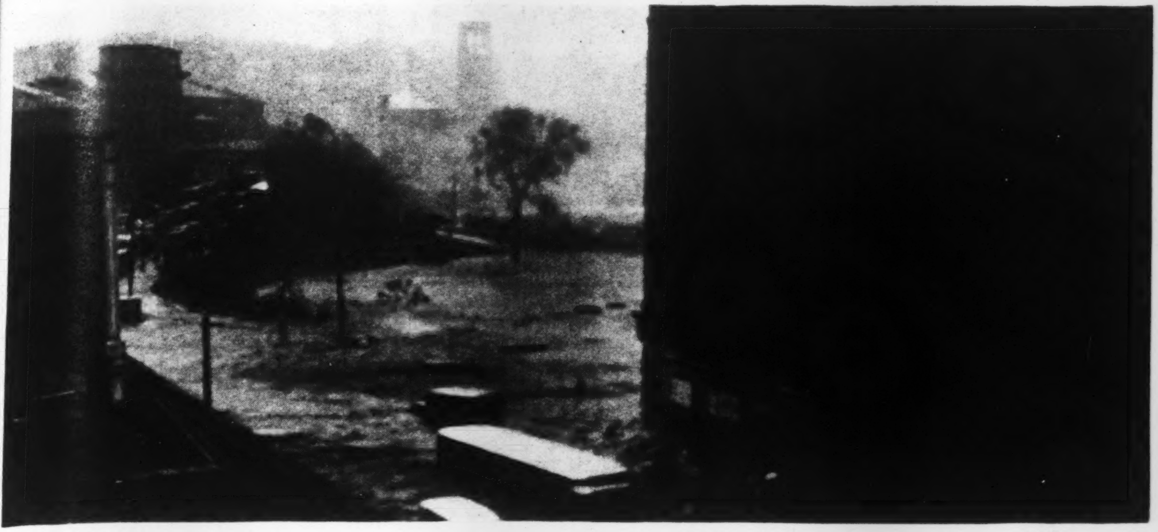

Fig. 1. Providence is crippled as storm tide engulfs business district and the civic center.

high-presure fire lines; the remaining two-thirds of the city is served by a gravity water system. The fire started at 4 p.m., the peak of the storm wave struck 15 min. later. Waterfront hydrants, mains and building connections were ripped open by the storm, yet despite this huge waste from the city's mains and the drain of nine fire pumping engines, the water supply never failed during the fire, though the pressure in the mains dropped to 5 lb. A fire engine was hooked up between a low-pressure and high-pressure hydrants to keep the high-pressure mains full. Intensive work in shutting off leaking outlets the next day rapidly restored pressure in the gravity supply system, and within 48 hr. emergency pumping equipment had water to all parts of the city. Power was restored at the pumping plant on Sept. 25.

The entire Merritt-Chapman & Scott Corporation fleet of lighters, floating derricks, tugs and barges, stationed at New London, was wrecked, sunk or blown ashore. As this fleet constituted a large part of the floating construction equipment available along the southern New England coast, clearing up of waterfront wreckage was delayed until plant could be obtained from other bases of the company.

Stonington and Watch Hill

A brief stop at Stonington revealed the type of damage suffered by shorefront communities, an indication of what was to be found farther east. Buildings facing the shore were wrecked by the score. Trees, boats, poles and demolished buildings were piled up in hopeless confusion. Streets were blocked by whole houses, and parts of the town's famed fishing fleet were deposited on lawns blocks from the shore. The Stonington breakwater was badly battered, and suffered some damage, the extent of which had not yet been determined.

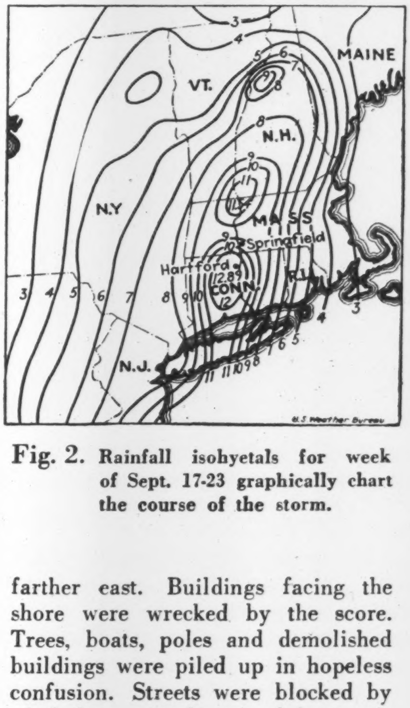

Fig. 2. Rainfall isohyetals for week of Sept. 17-23 graphically chart the course of the storm.

The next stop was Westerly and the adjacent shore communities of Napatree Point, Watch Hill, Misquamicut and Weekapaug Point. The devastation was at its worst along this shore. Over a beach area only 7 miles long, 106 lives were lost and 14 persons are still missing.

Dan Soule, highway superintendent of the town of Westerly, acted as a guide through this devastated area. His experiences in the village of Westerly following the storm are typical of the actions of numerous public officials, whose untiring efforts did so much alleviate the sufferings of stricken communities. He was caught by the storm on a return trip by car from Providence. Almost instantly the roads were blocked by fallen trees. Borrowing an axe from a farmer, Mr. Soule chopped for 3½ hours to get his car into town. It was then 7:30 p.m. and the village was without lights, power or phone service. Personally gathering up his small maintenance crew, supplemented by volunteers, Soule directed clearing of the streets to the hospitals, to the homes of doctors, and then to the fire houses. By midnight, dark as it was, the gang had cleared the main streets so fire apparatus might approach within 400 ft. of every large building.

It was just a week after the storm that the writer visited Watch Hill. We went first to Napatree Point, a long spit of sand curving westward from Watch Hill. Formerly some 50 substantial summer homes were on this spot. Today not even a bit of wreckage remains—everything, including occupants, was blown across the bay to the Connecticut shore. Watch Hill itself is on a rocky promontory. Its well-built homes largely escaped destruction, except for those low down on the waterfront.

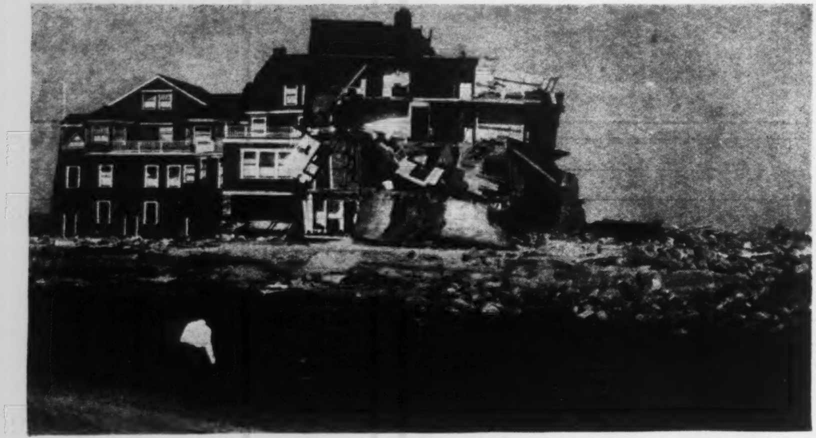

Fig. 3. Battered hulk of a summer hotel at Weekapaug Point is mute testimony of the storm's fury on the Rhode Island shore. In the foreground is one of several new inlets cut through the barrier beach.

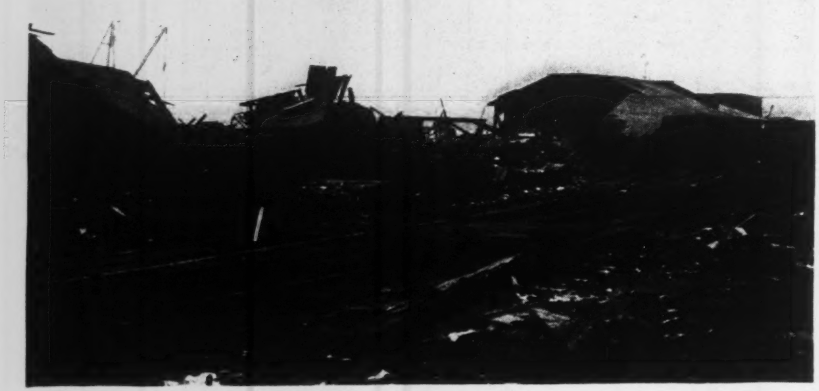

Fig. 4. Wind and water wrecked most of the Providence shipping terminals. This is a view of the Merchants & Miners wharf.

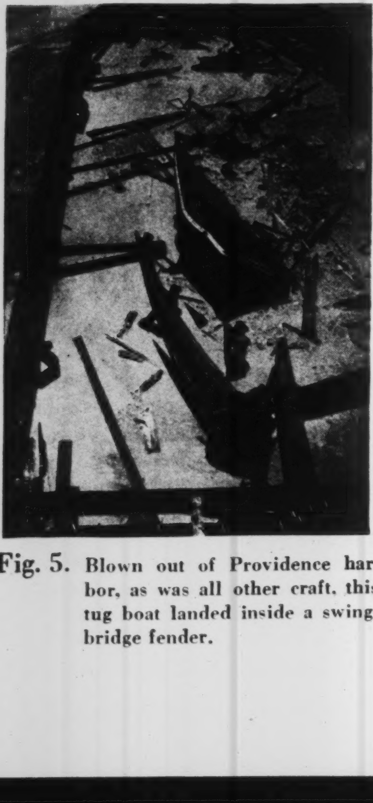

Fig. 5. Blown out of Providence harbor, as was all other craft, this tug boat landed inside a swing-bridge fender.

To the west of Watch Hill extends a long barrier beach upon which the communities of Misquamicut and Weekapaug were located, although the entire beach was pretty well built up with summer homes and hotels. All of this is in ruins—nothing but wreckage and devastation remains. In some places were high dunes, now swept away or eroded into strange patterns.

Providence

The Rhode Island metropolis on the Seekonk and Providence rivers at the head of Narragansett Bay, suffered severely from wind and storm tides. Director of Public Works Charles A. Maguire furnishes a graphic description of the storm and its results.

The tropical huricane, most devastating in the history of Rhode Island, with a maximum velocity of 95 m.p.h. coupled with a high tide occurring at 6.52 p.m., caused inestimable damage to property, taking many lives, and crippling all utility services. The winds forced a wall of water ahead of them, which superimposed upon the high tide, inundated an area of 1.4 sq.mi. in the very heart of the business section, in some places to a depth of 12 ft.

The flood line reached an elevation of 13.95 above mean high tide. Water began to flow over Exchange Place, the city's civic center, at 5:15 p.m.; the maximum was reached at 6:52 p.m. At 10:30 p.m. the waters had receded so that the flooded section could be traversed by pedestrians.

Every piece of equipment that could be used was pressed into service, and private contractors assisted by supplying all their available equipment.

Street lights were restored Monday, Sept. 26, but power in the downtown area was out of service for nearly two weeks. A few office buildings and the Biltmore Hotel set up emergency generators to supply current for limited elevator service.

Mr. Maguire pointed out certain salient facts in this crisis: the normal functioning of the waterworks and the distribution system and the sewage disposal plant; the mobilization of 7,000 workers and equipment; the speed with which highways were cleared and made accessible to fire apparatus and to necessary vehicular traffic; the cooperation of the utilities with the municipality in restoring normal services; and the response of the public in working with the city.

Col. J. S. Bragdon, Capt. H. J. Hoeffer and other officers of the Providence Engineer District furnished additional information about Providence and vicinity. Their chief worry at the moment was to get the navigation channels cleared in the Providence and Seekonk rivers. Sunken craft of all kinds, automobiles and tank cars blocked the channels, especially at the bridges. Lack of power hampered the operation of drawspans, and even auxiliary power plants at the bridges were disabled by the storm.

A quick survey by the Engineer Department placed the damage in Providence at $10,000,000. Much waterfront property was destroyed, particularly in the neighborhood of the Merchants & Miners Terminal.

Rhode Island

Other parts of the state also felt the fury of the storm. The barrier beach that continues eastward from Weekapaug Point was devastated all the way to Point Judith. Newport, on the east side of Narragansett Bay, was badly hit, and fashionable Bailey's Beach is in ruins. Along the west side of the bay the towns of Warwick, Wickford and Narragansett suffered severely. Destruction at Warwick includes the loss of 618 homes, a large part of the town's dwellings. The state's toll of dead, including the Watch Hill area, stands at 272, and 54 are still missing.

H. C. Thierfelder, deputy chief engineer of the state department of public works, reported that the damage to state roads would probably come close to $2,000,000. Eleven highway bridges were affected, some seriously, which will cost $350,000 to repair and replace.

Boston and Cape Cod

Col. A. K. B. Lyman, U. S. District Engineer at Boston, and his associates reported that Cape Cod communities were only slightly damaged. The Cape Cod Canal was not affected, except for a slight disturbance of riprapped banks, though the storm piled up a tide at the west end 11.4 ft. higher than the concurrent tide at the east end, a head 2 ft. higher than ever recorded in the history of the canal. The tide in Buzzards Bay reached 10.3 ft. above mean high water stage. At the west end of the canal the sand dike between Rocky Point on the south mainland and Hog Island was breached, though no trace of the lost material has been noted in the approach channel. The long Stony Point sand dike on the north side of the approach channel was actually built up during the storm. Shore property on Onset Bay was swept away. A small amount of debris blown into the canal was quickly cleared away. The high railroad lift bridge over the canal remained in open position all through the storm without damage.

A call at the various railroad engineering headquarters in Boston revealed serious damage by floods and slides to the west and northwest of the city. Main lines were tied up for days; some are still out.

Floods in the River Valleys

WALDO G. BOWMAN

Associate Editor, *Engineering News-Record*

THE FLOODS which damaged parts of New England two weeks ago were at once separate from and a part of the hurricane which devastated the ocean shores of this region on Sept. 21. They were separate in the sense that they were in the making for several days before the hurricane struck and continued to do damage after the wind blew itself out. They were a part of the hurricane in that the deluge of rain that rode the wind into the long narrow valleys of the Connecticut and Merrimack Rivers quickly ran off into streams already swollen by several days of rain, not only making floods certain but, by washing out upstream dams and releasing impounded waters, making them destructive.

The flood area

Although the storm, traveling north by slightly west, covered all of New England, its greatest contribution to floods occurred in a north-south strip which included the eastern tributaries of the Connecticut and the western tributaries of the Merrimack. The former include the Chicopee and Millers rivers in Massachusetts and the Ashuelot in New Hampshire; the latter the Contoocook and the Piscataquag in New Hampshire. In addition, such western tributaries of the Connecticut as the Farmington in Connecticut and the Deerfield in Massachusetts brought down a great deal of water. In these two major basins and in the streams which drain the watershed of the Thames in eastern Connecticut, the 1938 flood concentrated its greatest destruction.

First in the path of the hurricane, the short watershed of the Thames River, which enters Long Island Sound at New London, was in serious flood by the early evening of Sept. 21. Principal tributaries are the Quini-

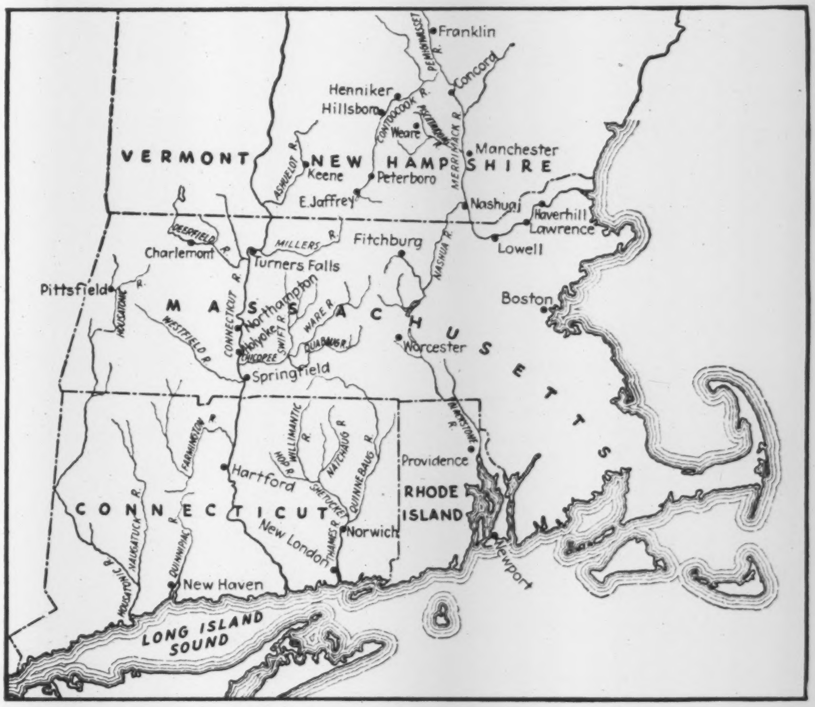
Franklin
PEMIGEWASSET R.
Concord
Henniker
Hillsboro
CONTOOCOOK R.
PISCATAQUOG R.
Weare
MERRIMACK R.
Manchester
VERMONT
ASHUELOT R.
NEW HAMPSHIRE
Keene
Peterboro
E. Jaffrey
Nashua
Haverhill
Lawrence
Lowell
DEERFIELD R.
Charlemont
MILLERS R.
Fitchburg
Turners Falls
NASHUA R.
Pittsfield
HOUSATONIC R.
MASSACHUSETTS
Northampton
CONNECTICUT R.
Holyoke
SWIFT R.
WARE R.
QUABOAG R.
CHICOPEE
WESTFIELD R.
Worcester
Boston
Springfield
FARMINGTON R.
WILLIMANTIC R.
HOP R.
NATCHAUG R.
QUINNEBAUG R.
BLACKSTONE R.
Providence
Hartford
SHETUCKET
RHODE ISLAND
CONNECTICUT
NAUGATUCK R.
QUINNIPIAC R.
THAMES R.
Norwich
New London
Newport
HOUSATONIC R.
New Haven
LONG ISLAND SOUND

Fig. 6. River basin regions affected by September floods. Only the most severely affected tributaries of the main streams are shown.

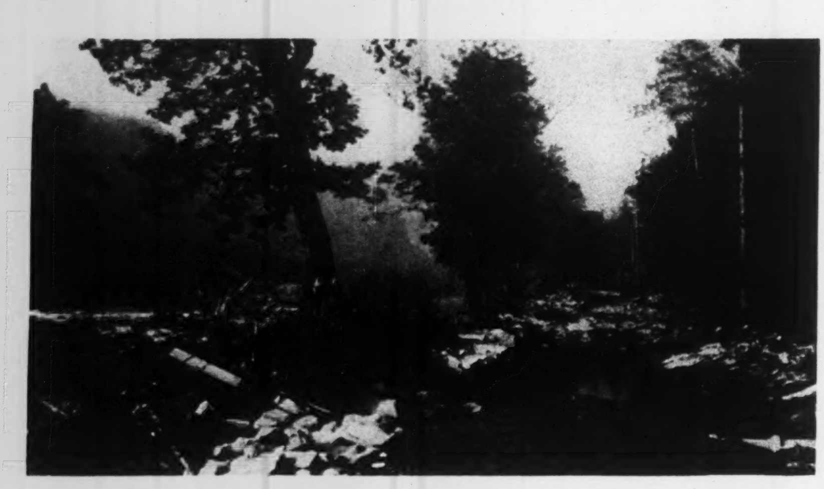

Fig. 7. End of the Mohawk Trail in Millers River valley west of Turners Falls. Major construction operations will be required to close this gap.

baug and the Shetucket, the latter forking into the Willamantic, the Hop and the Natchaug. All of these streams exceeded any previous stage at U. S. Geological Survey gaging stations, in some cases the figures being 8 to 10 ft. above 1936 records.

Highway and bridge damage, as well as village flooding, was particularly severe on these streams. The largest bridge lost in the state was at Norwich on the Shetucket—two 125-ft. steel truss spans. One of these spans was built in 1936, the other in 1922, but both were on foundations of an early bridge and undermining of these supports accounted for the failure.

The Connecticut Basin

The Connecticut River failed to reach 1936 levels by 2 ft. in Massachusetts and Connecticut and by greater amounts in New Hampshire. But, as in the Thames basin, Connecticut River tributaries set new all-time stage records in some cases. The Farmington in Connecticut, for example, was about 6 in. above 1936, the Chicopee in Massachusetts 5½ ft. above, the Millers in Massachusetts 3½ ft. above, the Ashuelot in New Hampshire 2 ft. higher. Above Brattleboro all Connecticut River tributaries failed to reach previous record stages by a good many feet. Flood damage, therefore, was confined to the southern half of the Connecticut River basin.

Hartford—Going up the Connecticut River, Hartford is the first major city encountered. Here the Connecticut River dikes along the south half of the city, raised since the 1936 flood, proved their worth; whereas $4,000,000 of damage was suffered two years ago in the area that they enclose, flood waters were kept out entirely this year. Credit for part of this achievement, however, must go to volunteer workmen and others who built a sandbag wall 4,000 ft. long and 5 ft. high during the wet night of Sept. 21 on top of the low section of the dike along the Park River, which enters the Connecticut through the center of the business section of the city. Maximum Connecticut River stage at Hartford was 35.3 compared with 37.6 in 1936. Had the tops of the dikes been at El. 35, as they were in 1936, they would have been overtopped. However, about three-quarters of the length of the Connecticut dikes had been raised to the design height of 45 ft.; the remainder was at 38.5 to the mouth of the Park River. North of this small stream, which cuts the city from west to east, there is no dike protection and here the flood came near to duplicating the inundation of 1936. The situation is summed up in the statement by Robert Ross, city engineer, that only 13 per cent of the city was flooded last week compared with 25 per cent in 1936.

Springfield and Vicinity—Springfield, too, had built dikes since 1936 and, partly as a consequence, only 50 per cent as much of the city was

COMPARATIVE RIVER STAGES AND DISCHARGES

Preliminary data from the Water Resources Branch of the U. S. Geological Survey

Location	Drainage Area Sq. Miles	'36 Stage	'36 Cfs Flow	'38 Stage	'38 Cfs Flow
Connecticut R. Basin					
Conn. R., Hartford	.....	37.6	291,000	35.3	263,000
Farmington R., Tariffville, Conn.	.....	13.4	....	14.0	......
Hockanum R., E. Hartford	.....	8.1	....	13.8	......
Conn. R., Holyoke, Mass.	.....	16.8	....	14.9	......
Salmon R., East Hampton, Conn.	.....	7.0	....	10.9	......
Conn. R., Montague City, Mass.	7,840	49.2	236,000	44.6	194,000
Conn. R., Springfield, Mass.	9,587	28.6	281,000	25.75	240,000
White R., Bethel, Vt.	241	6.7	16,100	9.3	32,000
White R., Hartford, Vt.	690	18.9	45,400	19.2	47,000
Ottauquechee R., No. Hartland, Vt.	221	15.6	19,200	17.7	23,200
Otter Brook, Keene, N. H.	41.8	7.1	3,580	7.9	4,500
Ashuelot R., So. Branch, Marlboro, N. H.	36.6	7.55	3,880	7.7	4,050
Ashuelot R., Keene, N. H.	.....	12.8	....	14.8	......
Sip Pond Brook, Winchendon, Mass.	19	12.4	1,430	13.7	2,100
Deerfield R., Charlemont, Mass.	362	14.2	32,200	20.17	56,000
Ware R., Coldbrook, Mass.	96.8	....	5,990	....	14,000
Chicopee R., Chicopee Falls	.....	9.9	....	15.4	......
Westfield R., Knightville, Mass.	162	24.1	25,700	29.6	33,700
Westfield R., below Westfield, Mass.	497	27.2	48,200	29.4	55,500
Millers R., Orange, Mass.	.....	10.9	....	14.4	......
Housatonic R., Coltsville, Mass.	57.1	10.14	6,670	10.8	8,290
Hoosic R., Adams, Mass.	46.3	6.3	3,670	8.2	5,600
Waloonsac R., N. Bennington, Vt.	111	11.4	6,600	12.1	7,400
Merrimack R. Basin					
Pemigewasset R., Plymouth, N. H.	622	29.0	65,400	19.0	35,700
Merrimack R., below Lowell	4,635	68.4	173,000	60.6	108,000
Contoocook R., Penacook, N. H.	766	14.26	46,800	13.4	42,700
Souhegan R., n. Merrimack, N. H.	171	16.2	16,900	12.8	10,900
Nashua R., n. E. Pepperell, Mass.	433	19.1	20,900	14.1	15,300
Thames R. Basin					
Quinebaug R., Quinebog, Conn.	.....	13.4	....	16.21	......
Quinebaug R., Putnam, Conn.	.....	17.3	....	19.45	......
Quinebaug R., Jewett City, Conn.	.....	24.0	....	21.72	......
Willimantic R., So. Coventry, Conn.	.....	12.2	....	18.1	......
Shetucket R., Willimantic, Conn.	.....	18.35	....	27.6	......
Hop R., Columbia, Conn.	.....	13.85	....	16.2	......
Natchaug R., Willimantic, Conn.	.....	13.3	....	16.35	......
Yantic R., Yantic, Conn.	.....	11.3	....	14.62	......
Shepaug R., Roxbury, Conn.	.....	10.8	....	11.8	......
Pomeraug R., Southbury, Conn.	.....	14.1	....	16.0	......
Housatonic R. Basin					
Housatonic R., Falls Village, Conn.	.....	....	14,500	....	11,000
Housatonic R., Stevenson, Conn.	.....	23.5	69,500	22.0	62,000
Naugatuck R., Naugatuck, Conn.	.....	12.0	....	12.4	......

flooded. Contribution to this better record was of course due also to the lower stage in the Connecticut. Although this river was 3.21 ft. above the 1927 stage, it was some 2 ft. below 1936—25.75 (city datum) compared to 28.66.

The raised dikes extending north from the North End Bridge completely protected this small section of the city. Furthermore, installation of new sewage pumps in the diked area eliminated some of the difficulty from severe sewage backups experienced in 1936.

New dikes in West Springfield kept the river out of an area in which $2,000,000 worth of damage was suffered in 1936.

The Chicopee River, which runs into the Connecticut just north of Springfield, was 5½ ft. above its 1936 stage with consequent great increase in destruction. Power and mill dams upstream were badly damaged. None went out but in at least three instances the Chicopee River cut a new channel around the dam and adjacent power canal. At Bircham Bend, for example, the channel, beginning a considerable distance upstream from the dam, is 500 ft. wide and 20 ft. deep.

The water released by the three dams on the Chicopee River accounted for the destruction of much mill property in Chicopee Falls and Chicopee, as well as the wrecking of the Chicopee Falls bridge. This structure, 392 ft. long and probably the largest and most important to go out in the 1938 floods, will be immediately replaced, according to state highway officials.

The Chicopee River is formed by the Ware, the Swift and the Quabaug. The Ware and Quabaug were particularly destructive, the villages of Ware, Gilbertsville, Palmer and Barre suffering severe losses, exceeding 1936. A 75-ft. stone arch bridge at Gilbertsville was wrecked, but three new multispan concrete girder bridges below, built after 1936, stood undamaged, although their approaches were completely washed away.

Upstream, at Holyoke and Northampton, flood damage from the Connecticut River was significantly less than in 1936. Water did not quite reach the floor of the S. Hadley Falls bridge at Holyoke which was badly damaged in 1936. Bethlehem Steel Co., erecting the new Calvin Coolidge Memorial Bridge over the river at Northampton, suffered only nominal inconvenience, losing time but no equipment, falsework or materials.

Millers River Damage—In every Connecticut Valley flood, the Millers River, a short eastern tributary in northern Massachusetts, has been the worst offender. This record was not spoiled in the recent flood. From its source near Winchendon to its mouth north of Turners Falls, it smashed factories, old dams, highways and bridges in typical manner. None of the new bridges built after the 1936 flood were washed out but in several instances the railings were destroyed by water that was 3½ ft. higher than in 1936. The flood control plans of the Army Engineers show five detention reservoirs for this stream and its tributaries, and some of these will unquestionably be among the first to be built if and when the general flood control program becomes effective.

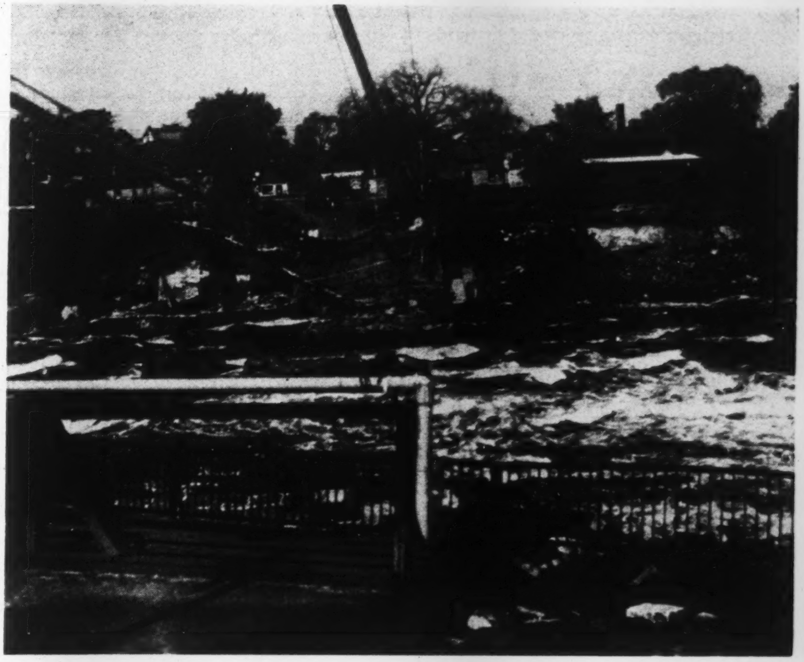

Fig. 8. A 400-ft. opening where the Chicopee Falls Bridge stood. The telephone cables were shot across by a Coast Guard gun.

Deerfield River — Although the Deerfield River, western tributary of the Connecticut in northern Massachusetts, registered a discharge at Charlemont of only about 60 per cent of 1936, a mile of the Mohawk Trail was washed out at this point. This is a local situation caused by extremely heavy runoff. The river itself is effectively controlled by power dam reservoirs.

Ashuelot River—In New Hampshire, the Ashuelot was the principal Connecticut River tributary in flood. Discharge was greater than in 1936, completely isolating the village of Keene by small bridge washouts, and inundating the business section. Damage, however, was not great since the village is on a wide flat which reduces the velocity. Two upstream reservoirs are in the federal flood control plan for this stream.

The Merrimack Valley situation

The other New England drainage basin in which major flooding occurred is the Merrimack Valley. As on the Connecticut, extensive damage was confined to tributaries, and of these the Contoocook and Piscataquog were the only ones to approach the 1936 stage and discharge records.

Considering the main stream first, preliminary discharge figures at a dozen points, rather evenly spaced from source to mouth, are between 60 and 70 per cent of the 1936 figures. For example: Manchester, 91,000 compared with 146,000 sec.-ft.; Nashua, 98,000 compared with 159,000; Haverhill, 112,000 compared with 177,000. For those points where comparisons are available with 1927, it is evident that the 1938 discharges are greater by about 30 per cent. The Contoocook discharge of 42,700

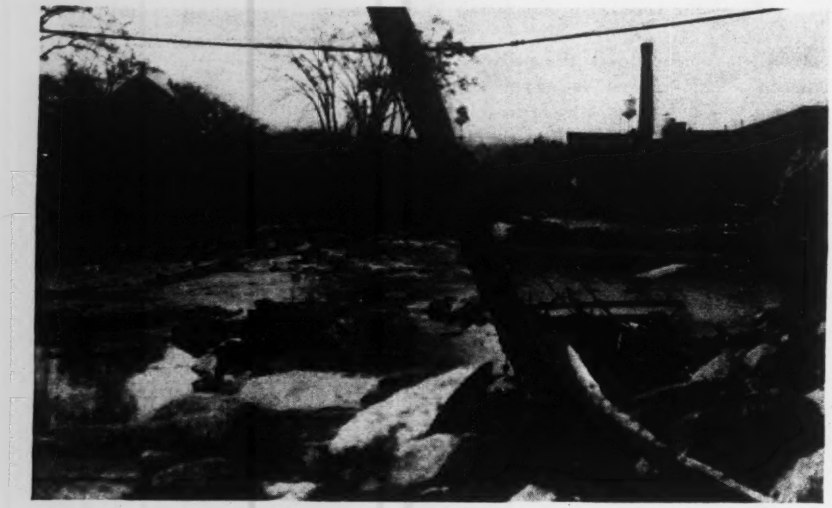

Fig. 9. What a dam failure did to Baldwinsville, Mass., on a tributary of the Millers River. Typical of village conditions in this region.

sec.-ft. compared with 46,800 in 1936 or 91 per cent. Discharge figures on the Piscataquog are not yet available but judged by damage they must have exceeded 1936, at least in the upper reaches of the stream.

Direct flood damages on the main stream and tributaries probably approximate $4,000,000, of which it is estimated 75 per cent would have been eliminated had the proposed Franklin Falls reservoir on the Pemigiwasset and the Riverhill reservoir on the Contoocook been in existence. No reservoir had been planned on the Piscataquog inasmuch as its floods had never been severe. Nor does extreme high water in this stream in last week's storm reflect on this decision since it was caused by a dam break at the Weare reservoir.

Contoocook River—With its headwaters in the region of highest precipitation, the Contoocook, western tributary of the Merrimack, almost duplicated its 1936 discharge, aided in large measure by failure of the dam gates which control Lake Contoocook at Jaffrey, near the source of the river. Direct damages on this stream, however, were about $150,000 compared with twice as much in 1936. Some of this saving resulted from the fact that fewer bridges were lost, all new 1936 structures standing up. At Hillsboro, thousands of feet of lumber riding the flood crest took out a masonry arch over a mill dam. A new bridge under construction at Jaffrey had its cofferdam washed out. At Henniker, a two span masonry arch, which was rebuilt after the 1936 flood with a reinforced concrete arch inside, collapsed when the old foundations were undermined. At this same village, the river went around both ends of two mill dams. These were the principal points of damage, to which are added many small bridges in the upper reaches of the stream. Peterboro was particularly hard hit because a fire broke out. Several buildings burned and only a sudden shift in the wind saved the village from complete destruction.

Piscataquog River—Failure of the Weare water supply reservoir on the Piscataquog gave this stream its destructive force; 14 old bridges, 20 to 60 ft. long, in the Weare area were washed out.

New dike system

Since the 1936 flood, the Corps of Engineers has built a number of flood control works in various cities using WPA funds. The situation at Hartford and Springfield on the Connecticut has already been described. In the Merrimack basin, concrete walls and riprap banks carry the Nashua River on its winding course through the city of Fitchburg. Discharge this year was 8,000 sec.-ft. compared with 9,000 in 1936. The city, however, suffered no damage, a 2½ to 3-ft. freeboard being available on the new wall. The Cushing St. bridge, a two span masonry structure which constricted the channel at one point, was washed out as was a sewer crossing of the river downstream from the city. Each of these washouts had been foreseen as inevitable both by city engineers and the Army Engineers, and reconstruction will provide improved channels at these points.

At Lowell, the enlarged river channel lowered the Merrimack flood about 3½ ft. at this point. At Haverhill, Mass., a concrete wall, built to protect a low-lying area in the center of the city, had a freeboard of about 2½ ft. at the crest of the Merrimack flood, but, inasmuch as the municipal authorities had not yet completed their sewage pumping plant and sewer outlets, the flood wall was not in service.

Bridge damage in general

Although several hundred bridges were washed out in the recent flood, their total value is much less than that occasioned by the 1936 flood. The extensive bridge building program completed since the 1936 high water provided flood-safe structure.

Connecticut lost 30 bridges on the state highway system compared with only 12 in 1936. Only four of these were of major size and only one a relatively new structure. Some $250,000 will be required to replace these bridges in Connecticut. In Massachusetts, 20 state highway bridges are out, of which four are relatively large: a 100-ft. span concrete arch over the east branch of the Westfield at Cummington; an 80-ft. concrete arch at Williamstown; two 87-ft. reinforced concrete T-beam spans with a 40-ft. roadway over the Quabaug near Palmer; and a three-span steel stringer bridge, 175 ft. long, over the Quabaug at Dudley. The latter two bridge failures resulted from a dam washout on the Quabaug. In contrast to the state highway bridge losses, preliminary reports to the state highway department indicate that 375 other bridges, mostly small, were washed out, most of them completely demolished.

In New Hampshire the bridge and highway loss, while relatively large in number of structures, will not bulk large in dollars. In Vermont only two state highway bridges have been reported lost—a new steel girder span at Wilmington and a two-span concrete T-beam north of Bennington, which was soon to be abandoned anyway.

Finding Leaks in Water Mains

Vacuum tube amplifier outfit has selective qualities and emphasizes sounds made by leaks

LEAK-FINDING equipment that has selective qualities had to be developed by the East Bay Municipal Utility District at Oakland, Calif., because at the time no apparatus was found on the market that would eliminate interfering noises and give desired emphasis to sounds made by leaks. The objective sought in assembling the equipment was an outfit that would not be sensitive to noises from traffic, wind, and other sources usually much louder than leak noises. This was accomplished by the use of a piezoelectric pickup for ordinary service in city streets, and reluctance or magnetic pickups, usually more sensitive where interfering noises are not a consideration.

Even where evidence of leaks is visible on the ground surface the use of a listening device for spotting them exactly saves time and cost because the visible indications may not be directly over the source of trouble. Moreover, an important use of the equipment is the periodic exploration of the system to locate leaks that give no surface indication and yet may involve considerable water losses.

Fundamentally, the principle employed is location of the leak by tracing vibrations, in the audible range, produced by the escaping liquid. The percentage of leaks in which such sounds can be heard by the unaided ear is negligible. In some cases they may be heard by pressing the ear against an exposed valve stem or other portion of the pipe, or by a metal rod which is thrust into the ground to touch the pipe and provides a conductor from pipe to ear. However, nearly all leaks occurring underground are muffled, and some means of picking up and amplifying the sound is a practical necessity.

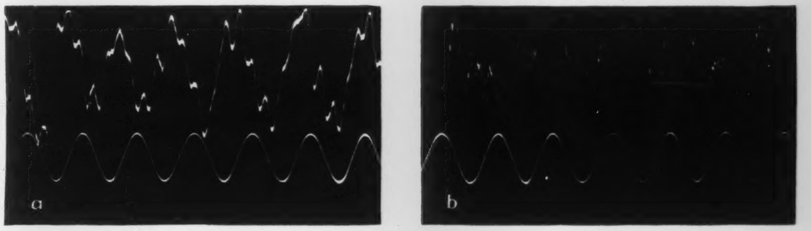

Fig. 1. Two oscillogram records of the same vibrations; *a*, with a magnetic microphone, almost loses high-frequency leak noises while *b* gives them major emphasis.

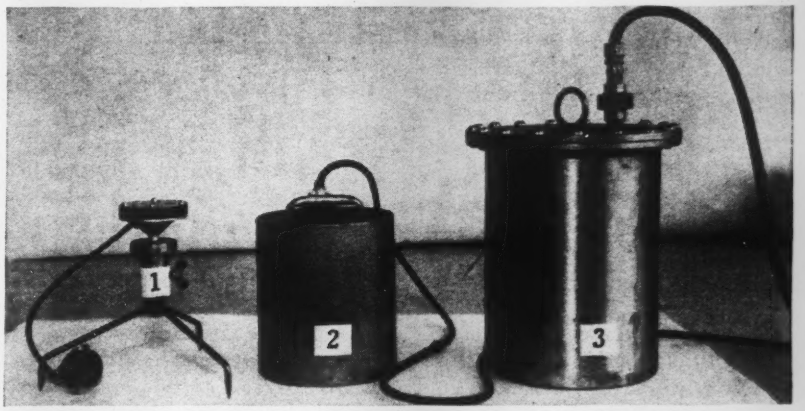

Fig. 2. Microphones of three types for use in listening for leaks: (1) piezoelectric unit (on tripod used on concrete pavements); (2) magnetic pickup in case and (3) hydrophone for locating leaks in submerged pipes.

Amplifying equipment introduces difficulties in making the apparatus selective to the particular vibrations under consideration. The vibrations themselves as well as the strength and frequency of their harmonics are influenced materially by such factors as pipe size, material and thickness; size and shape of the hole through which the water is escaping, pressure in the line, and the nature of the material surrounding the pipe. Experiments with various simple forms of listening devices led in 1934 to adoption of vacuum-tube amplifiers as best adapted to the work. Essentially the equipment consists of microphone, amplifier and ear phones.

Because the microphone is the most important element of the outfit, particular attention has been given to selecting a type suited to the vibration range of leaks in water mains. The most offensive of the interfering noises have frequencies below 1,000 cycles per second, while the leaks themselves are usually of considerably higher frequency. Experiments led to the selection of a microphone not very sensitive in the 1,000-cycle range, and with a sensitivity peak at about 3,000 cycles.

Reasons for this choice became apparent from the oscillograms reproduced in Fig. 1. In this figure, *a* was made with an ordinary magnetic microphone which is designed to be equally responsive to vibrations over a wide frequency range. The loudest noise produced the largest amplitude and the noises from the leak under investigation caused the small-amplitude vibrations which are superimposed on those of large magnitude. In this curve, therefore, the record of the leak noises appears on the oscillogram at the peaks of the interference curve as a wide line.

The oscillogram marked *b* records the same noises and at the same spot as *a*. This record was taken with the piezoelectric pickup, highly sensitive to vibrations of the order of 3,000

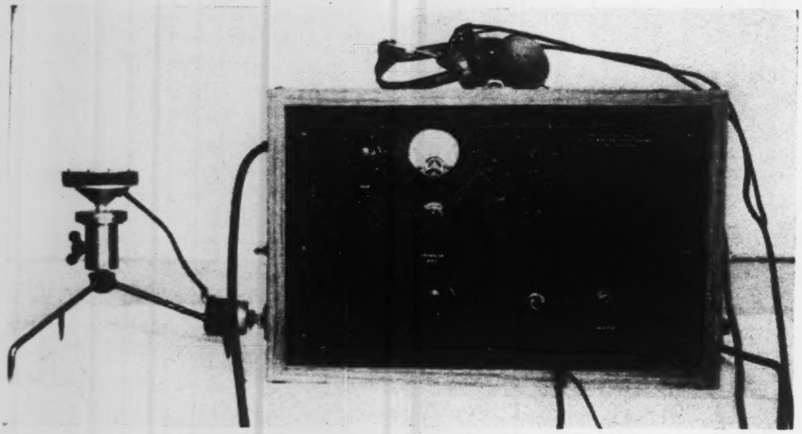

Fig. 3. Piezoelectric microphone with amplifier unit and head set.

cycles. The high-frequency high-amplitude wave recorded is from the leak (the same one shown by small amplitude waves in the other oscillogram) and the record of the interfering noises is the envelope of the high-frequency wave. In other words, upper and lower limits of the interfering noises would be indicated by lines connecting the extreme points of the higher-frequency amplitudes recorded. The lower, even wave in both oscillograms is a 60-cycle timing wave. These two oscillograms clearly indicate the advantage of having the pickup sensitive primarily to the vibrations under study.

In Figs. 2 and 3 are shown the equipment as used in the field; with the equipment shown no oscillograms are made and dependence is upon audible indications via the headset. In Fig. 2 the number 1 indicates the piezoelectric pickup unit mounted on a metal tripod for use on concrete pavements. The small circular object with inverted conical base at the top of this unit is the microphone itself; this can be taken off the tripod and mounted on a steel rod for probing to pipe depth where feasible.

The number 2 indicates a magnetic microphone mounted in a metal case that can be used either on tripod or probing rod. The unit marked "3" is a watertight case for the magnetic or piezoelectric type used for exploring leaks in subaqueous pipes. The microphone is fastened to a lug on the inside bottom of the case and the assembly is lowered in the water to as near the pipe as possible, by a hemp or cotton rope. Metal suspension is avoided because this would transmit surface noises to the unit.

Fig. 3 shows the amplifier and ear phones used in conjunction with the pickup unit. Batteries required for operation of the amplifier are not shown. (When equipped with an exploring coil and used in conjunction with a vibrator this amplifier may also be used in locating the route followed by pipes below the surface.)

The use of this equipment has on numerous occasions reduced the time involved in locating known leaks from several days (with an excavating crew, to a few hours with the leak finder), and reduced the cost correspondingly. In general surveys leaks have been discovered as small as two or three gallons per minute, at depths greater than 10 ft. These leaks otherwise would probably not have been found until they had greatly increased in size.

Notes for the foregoing record of experience on this system were obtained from the East Bay Municipal Utility District; J. S. Longwell, chief engineer and general manager and H. A. Knudsen, mechanical and electrical engineer.

Story of a State Line

Indefinite agreements and faulty surveys extending over 260 yrs. make the New York-Connecticut boundary history an unusual one

Doubtless every surveyor has his favorite tale of a boundary dispute. Some of these are between small lot owners and some others between nations. Making the Connecticut charter fit those of three other states has been almost a three-century job, which was described at the annual meeting of the Connecticut Society of Civil Engineers by Henry W. Buck of Hartford. Excerpts from his paper are given below and tell a typical story of boundary disputes in the original states as well as the newer ones.

EDITOR

THE BOUNDARIES of the state of Connecticut were established in their present location only after many years of controversy with neighboring states. England based her claims to the territory which is now the state of Connecticut on the discoveries of John Cabot in 1497. For more than 100 years, however, no attempt was made to establish colonies in this region. In 1620 the "Council of Plymouth for the Affairs of New England" was granted the right of settlement in the land between New Jersey and the St. Lawrence River. The Connecticut patent was originally granted to the Earl of Warwick in 1630. The following year it was conveyed to Lord Say and Seal, Lord Brooke, Sir Richard Saltonstall and others associated under the name of the Plymouth Company. It was not until 1662 that the Connecticut charter was granted, covering the territory bounded north on the line of the Massachusetts plantation, east on Narragansett Bay, and south and west on the seas with the islands adjacent thereto.

While according to this the Connecticut charter extended west to the Pacific Ocean, actually the Dutch settlements at New York restricted the western limits of the colony. An agreement was reached with the Dutch in 1650 dividing Long Island at Oyster Bay, the easterly portion to be under Connecticut and the westerly portion under Dutch jurisdiction. On the mainland the line was to start at the west side of Greenwich Bay and to run north 20 miles and to be continued as agreed later, provided, however, that it would not come within ten miles of the Hudson River. This agreement was never ratified by the sovereign governments.

In 1664, the King granted the territory lying west of the Connecticut River and all of Long Island to his brother, the Duke of York, who fitted out an expedition and seized Manhattan. This grant was in direct conflict with the previously issued Connecticut charter. The Connecticut colonists immediately sent commissioners to New York, who concluded an agreement which provided "that the southern bounds of His Majesty's colonie of Connecticut is ye sea and that Long Island is to be under the government of His Royal Highness, ye Duke of York," and further "that the creek or river called Momoronock which is reputed to be about 12 miles to ye east of West Chester, and a line drawn from ye east point or side where the fresh water falls into the salt and high water marks, north-northwest to the line of Massachusetts, be the western bounds of ye said colonie of Connecticut." (See Fig. 1).

New York later claimed that they were assured that this line would be everywhere 20 miles east of Hudson's River, whereas actually it crosses the Hudson just above Peekskill. The starting point selected was, however, the western limit of the Connecticut settlement, Rye being a Connecticut town and the inhabitants wishing to remain under Connecticut jurisdiction. Moreover, Connecticut had given up her territory on Long Island, so that the Connecticut claims were not as unjustified as has frequently been made to appear.

Several unsuccessful attempts were made by joint commissions to establish the boundary, New York insisting on a line 20 miles east of the Hudson River and Connecticut refusing to give up her jurisdiction over towns along the sound located west of such a line. An agreement was finally concluded on Nov. 23, 1683, which was the basis of all the new surveys of the line. The phraseology of this agreement led to much dispute as to the proper way to make the survey:

"It is agreed that the bounds, meets, or dividend between His Royal Highness's territory . . . in America and the colonie of Connecticut for ever hereafter shall begin . . . at . . . Lyon's Point (point A, Fig. 1) which is the eastward point of Byram River and from the said point to go as the river runneth to the place where the common road or 'Wading place' over the river is, (B) and from said road or 'Wading place' to go north-northwest into the country so far as will be eight English miles from . . . Lyon's Point (A to C) and that a line of 12 miles be measured from the said Lyon's Point according to the line or general course of the sound eastward (AD). Another line (DE) shall be run from the sound 8 miles into the country north-northwest, and . . . that a fourth line (CE) . . . from the northwest end of the 8 mile line . . . with the first measured line (ABC) shall be the bounds where they shall fall to run; and from the eastward end (E) of the fourth . . . line . . . a line parallel to Hudson's River in every place 20 miles distant . . . shall be the bounds . . . ; only it is provided that in case the line from Byram Brook's mouth north-northwest 8 miles (ABC) and the line (CE) . . . run 12 miles to the end of the third . . . line . . . do diminish or take away land within 20 miles of Hudson's River . . . then so much . . . shall be added out of Connecticut bounds unto the line . . . parallel to Hudson's River . . . ; the addition to be made the whole length of said . . . line and in such breadth as will make up, quantity for quantity what shall be diminished as aforesaid."

Under this agreement Connecticut lost her jurisdiction over Rye and the towns of Long Island, but retained jurisdiction over the other shore towns west of the 20-mile line by relinquishing an equivalent area along the remainder of the line.

1684 survey

A portion of this line was surveyed the year following the agreement. This was the first survey of the line and so far as it went remains today the boundary between the two states. John Herriman was the surveyor for Connecticut and Philip Welles the surveyor for New York. They measured from Lyon's Point at the Byram River to the great stone at the "Wading place" and then proceeded north-northwest. They marked 3.03 as the angle point (C). Then they ran a line to the Hudson River (CF) and agreed that the river bore north as to its general course. Returning to the angle point (C), they decided to disregard the instructions of the agreement and instead of running a second 8-mile line (DE) north-northwest from the sound and 12 miles to the east of the first line, they ran a course from the angle point (C) east-northeast which they agreed was the bearing of the shore line. They computed that a line 20 miles from the Hudson would intersect this line 13 miles 64 rods from the angle point (C) and at this point (H) erected a stone heap to mark the southwest corner of the equivalent line. The area

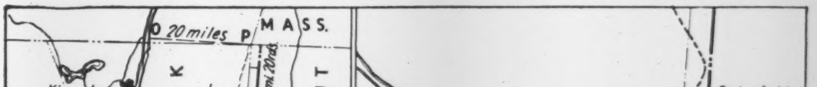

Fig. 1. Maps showing points used in developing the present Connecticut-New York state line.

cut off from New York was taken as 61,440 acres (8 miles by 12 miles) and assuming that the Massachusetts line was 100 miles to the north, they agreed that the so-called ("oblong") or equivalent lines should be 305 rods wide.

In ensuing years, joint commissioners met several times, but little progress toward fixing the lines was made. The principal difficulties were that the point designated for the southwest corner of the equivalent land (E) was not 20 miles east of the river as had been believed when the agreement was drafted and that the irregularity of the river made a line 20 miles east of it practically impossible to lay down on the ground.

Finally, it was agreed that the Herriman and Welles point (H) was to be taken as the true southwest corner of the oblong, whether or not it actually was 20 miles from the Hudson. It was further agreed to run a line (LM) 20 miles east from Cortland's point and a line (OP) 20 miles east by south from the river to the Massachusetts line, and that a line drawn through these three points (HMP) would be considered 20 miles from and everywhere parallel to the river. The computation of 61,440 acres for the area of the "oblong" they agreed to accept, but the width of 305 rods was thrown out, to be refigured after determining the correct distance to the Massachusetts line.

The character of surveying contemplated is best shown by the fact that surveying regulations provided that in most lines 12 rods were to be added to every mile taking the "ye rough and ye smooth land together into ye computations. . . ." It was further agreed that to avoid confusion and disputes, only one compass would be used, this compass to be selected as the nearest correct of all submitted, and that no regard would be made of the variation of this compass from the meridian. For the work done it appears that the compass used had a declination of 9 degrees to the west.

In 1730 Edmund Lewis and Cadwallader Golden marked the angle in the western bounds of the oblong 20 miles east of Cortland's Point (M) and they then ran a random line to Massachusetts and marked the northwest corner of the "oblong" (P). The width of the oblong was computed as $1\frac{3}{4}$ mi., 20 rods. At this point they made a decision which caused all the subsequent disputes on this line. Instead of setting off the width of the "oblong" at both ends and the angle, and running the state line, they ran the western bounds of the "oblong" and set monuments on the line by running perpendiculars $1\frac{3}{4}$ mi., 20 rods to the east, generally 2 mi. apart. As they were "taking ye rough and ye smooth lands together," this left the actual monuments on a crooked line.

For over a century no further work was done on this line. In 1856 a joint commission ran the line as far as the Ridgefield angle. From here the Connecticut commissioners wished to run a straight line to the Massachusetts corner while the New York commissioners wished to follow as closely as possible the crooked line previously monumented. The straight line was run and found to add about 2,600 acres, including the village of Hitchcock's Corners, to Connecticut. Neither state was willing to yield its position and the work was discontinued. The New York legislature then empowered the New York commission to run the line ex-parte which they did in 1860 without the assistance or consent of Connecticut. This line as monumented followed all existing points on the 1730 line except that the 12 mile monument was moved 151 ft. west and the 33 mile monument was moved 750 ft. east to correct serious errors in the 1730 line. The 1860 stones were not set securely, and in 1909 a resurvey was made by Henry R. Buck, the procedure following closely that described in connection with the Connecticut-Massachusetts re-survey of 1906. The angle points described in the 1860 survey were adhered to, though intermediate points did not agree exactly with the old locations, due partly to the greater accuracy of later work and partly to movement of the stones. In 1913 the description of this line was accepted by the two states, but was not ratified by Congress. In 1922 when a question arose along the northern section as to the exact location of the line, an act was passed by the New York Assembly instructing the state engineer to re-survey this portion, repudiating the agreement of 1913 and legalizing the description of 1860. This section was accordingly re-survey and no errors found. The 1909 description was formally ratified by Congress on Jan. 10, 1925.

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Geological Survey Reports Water Level Conditions

An annual inventory of water supplies in twenty-eight states and the territory of Hawaii is being issued by the U. S. Geological Survey. The report covers ground water level conditions and pressures in artesian wells, comparing 1937 figures with those of other years. Special emphasis is given to areas of heavy pumping or artesian flow. In 1937 net rises of water level occurred in many observation wells unaffected by heavy withdrawals in the eastern and western parts of the United States, and net declines occurred generally in observation wells in the middle part. The annual changes in water level correspond rather closely to the departures from normal annual precipitation for these sections. The precipitation in 1937 was above normal in all eastern states and in most of the western states, whereas it was below normal in most of the middle states, especially in the Great Plains. The water levels in observation wells in areas of heavy withdrawals fluctuated also with changes in the rate of withdrawal and thus the changes in water levels in 1937 in many intensively developed areas do not correlate closely with the precipitation.

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Temperatures Investigated In London Subways

A detailed study of temperatures in London subways is being conducted by the London Passenger Transport Board for the purpose of assisting the engineers in preparing plans for additional ventilation when heavier services begin next year as a result of a $200,000,000 extension plan.

According to findings of the investigation, the temperatures in the subways are much below surface temperatures. In addition to being cooler, the air in the subways is drier, is scientifically ventilated and is moving constantly. Preliminary plans are being discussed which would cost about $2,500,000 and would include the installation of 30 more ventilating plants, bringing the total to more than 100.

Earth Roads in the South–V

C. S. Hill

Associate Editor, *Engineering News-Record*

South Carolina

In processing soils with tar and cement for road-base construction South Carolina has blazed the way to technical accuracy and definite specifications

One gets an impression of contrast in thinking as he goes from earth road observation in Georgia to talks with the highway engineers of South Carolina. Experimentation in processing soils with artificial binders to build stable bases comes up almost at once as a topic and naturally enough: South Carolina might very properly be called the testing laboratory of the South for processed-soil road basis. It began early, as soil stabilization in road building counts time, with processing experiments and every year since has undertaken more ambitious test-road building. The development story is interesting if there was time to tell it, but the test determinations call for all the space available.

The highway setup

Orientation, however, comes first. South Carolina has no secondary highway system like its two neighbors immediately north or even to the degree that Georgia has in its post-road system. All roads not in the state system are under county administration. The state system consists of 7,371 mi. of road which includes 1,260 mi. of county roads which have been added to the system in the past three years. The 1938 act of the legislature which provided for adding 660 mi. to the system prohibits any further addition without legislative authority. It is expected, however, that future legislatures will provide for adding other roads to the state system.

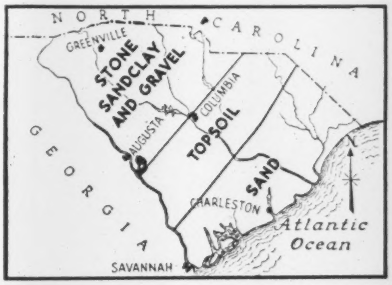


Fig. 2. Road soil distribution in South Carolina.

Few of the counties have engineers to plan and supervise their work. One cent of the state gasoline tax is distributed to the counties on the basis of motor vehicle registration. This gas money supplies all the funds used for road work in some counties but others supplement it with funds received from other forms of taxation. As a general rule, the work done by the counties is maintenance of the roads and bridges, very little construction work is done except in the counties drawing a high percentage of the gasoline tax.

Earth road building as observed in South Carolina is then state practice and this is bituminous surface treatment on a stabilized base. The prevailing base course soils are top soil, sand-clay, clay gravel and a small quantity of disintegrated granite distributed roughly as shown by Fig. 2. All are used as natural soil bases in combinations that are stable and some of them are stable as found. Of them all the disintegrated granite used for road base alone calls for definition; it is a partly decomposed rock that can be excavated and broken up without a crusher and

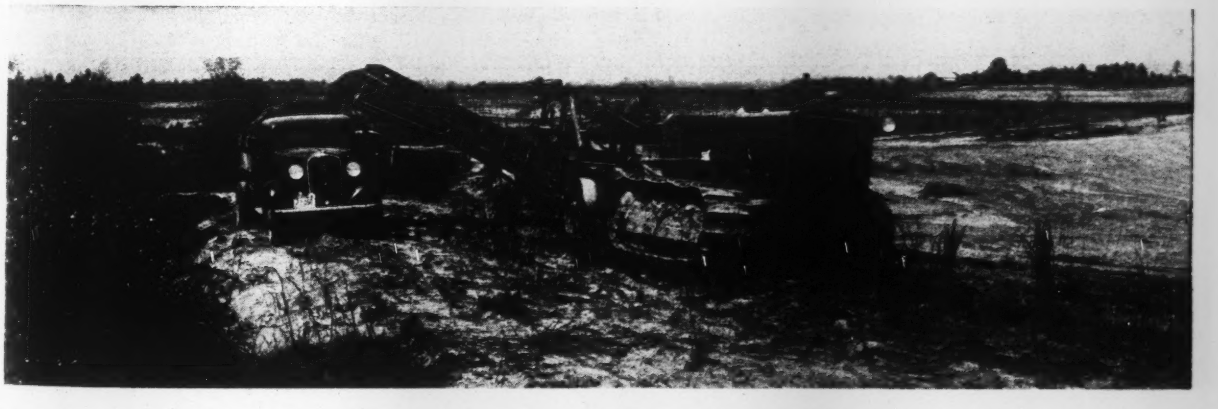


Fig. 1. Tractor-hauled elevating grades loading trucks on a South Carolina road.

contains quartz and enough binder for a stable mixture.

These natural soil bases are proportioned, and laid down, mixed and compacted in a way that varies in no essential from practices common in the South and outlined in preceding articles. Methods of surfacing (surface treatment) are also those common in the South as previously described. In South Carolina a double surface treatment is employed that is a tar prime, a hot asphalt application of 0.4 to 0.45 gal. per sq. yd., and a coarse aggregate ($\frac{1}{4}$ to $1\frac{1}{4}$ in.) spread uniformly, 47 to 50 lb. per sq. yd., and rolled in; then between two days and six months later the first treatment is given a seal coat of two applications of cutback asphalt between which is spread $\frac{5}{8}$-in. to 16-mesh aggregate at the rate of 16 to 18 lb. per sq. yd.

In surface treatment with cotton-cloth reinforcement, South Carolina was the first state to begin experimenting, and it has continued to experiment all through the recent free-cotton-for-roads grants by federal agencies. As it was gathered, opinion is far from favorable to the process; indeed the feeling is that the same amount of money put into a better base is more profitably spent, but fabric is considered valuable on wood floors on bridges and in the retreatment of certain bituminous-surfaced roads.

As indicated, stabilized natural soil bases prevail in earth-road construction in South Carolina, and the state has plenty of soils that can be so handled but also in many places the soils are definitely unsuitable. To meet these conditions the state highway department has turned to soil processing and in this work it has attained real distinction. With tar and with portland cement processing it has laid down the practices now everywhere accepted, and the sand-asphalt bases which it uses are very successful. The method of constructing sand asphalt bases is generally known and need not be amplified here.

Pioneering with cement

South Carolina was not the first state to putter around with cement-soil mixtures but it was the first to come out with reasonably definite data in an article in *Engineering News-Record*, Nov. 23, 1935. The results were reported by W. H. Mills, Jr., then and still department testing engineer who has been associated with most of the processing experiments.

The Portland Cement Association after inspections of the early experiments in South Carolina decided to conduct the soil-cement research outlined in *Engineering News-Record*, June 22 and July 7, 1938, and was ready to go into a field test. This was undertaken in the fall of 1935 and was a cooperative project between South Carolina State Highway department, the U. S. Bureau of Public Roads and the Portland Cement Association. The laboratory and field results on this project were reported by W. H. Mills, Jr., at the 1936 meeting of the Highway Research Board and reviewed in *Engineering News-Record*, Dec. 3, 1936. Out of this test-road study came the recommended construction procedure outlined in the second (July 7) article of the two noted above.

A decade of tar studies

In processing with tar the South Carolina testing department has again a large place in the story, and what follows comes from W. H. Mills, Jr., and his assistant, A. P. Bolton. South Carolina began very early to seek what might be done with tar to firm unstable soils. Over ten years ago a 0.4 mi. section of road was built of very fine sandy soil processed with tar; but about that time the state began to develop a large program of rigid-type pavements and lesser problems were crowded into the background.

It was not until 1935 that real study was begun on one mile of road and the first big lesson of tar processing was learned. It was that tar would mix better with moist soil than with dry soil. A test was made on 700 ft. of road with the soil moistened to about the plastic limit; this test showed definitely that the tar mixed more perfectly with the wet soil, but another trouble was run into. When tar was mixed with so wet a soil the liquid content became so high that the mixture did not compact under a sheepsfoot roller. The next test was made with these lessons in mind and two 1-mile sections of road were processed. This test was followed by several others, some to determine the minimum quantity of tar and others to try out different kinds of soils. Adequate accounts of individual tests have been put on record in the writings of Mr. Mills and of E. O. Rhodes of the Koppers Co.

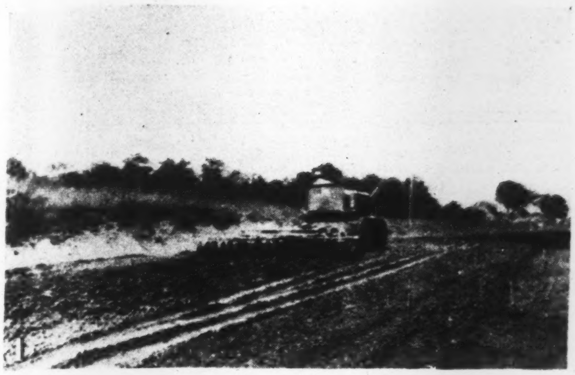
Some of the broader lessons, however, call for notice. First perhaps was the determination that a moist soil took the tar better than did a dry soil. Incidentally this had been learned in the laboratory work of the Koppers Co. As previously stated it was also found that there must be moisture control if sheepsfoot roller compaction was to be successful and a modification of the Proctor tests is used as follows:

Instead of a 5-lb. rammer dropped 12 in., a 12-lb. rammer dropped 22 in. is used. This of course results in greater density and a lower optimum moisture content for compaction than is obtained by the regular method. It is used because the regular method gives a water content sufficiently high to lubricate the soil particles when tar is added. This affects both compaction and cracking. Laboratory tests indicated that a water content slightly more than the optimum for soil compaction was sufficient for easy mixing.

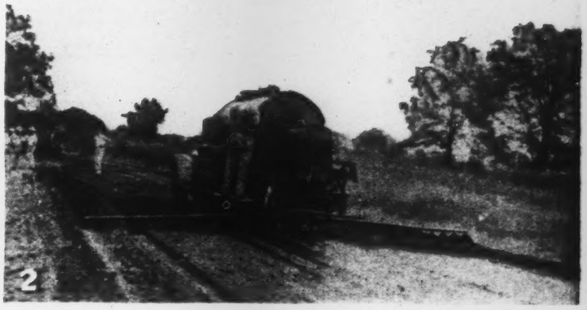
Tools for tar processing

As described by Mr. Mills, mixed-in-place methods of construction have been the only ones used; a good picture description of processes is given on the opposite page. Mr. Mills emphasizes the use of powerful machines and lists the minimum equipment necessary as follows: crawler tractors of 75, 50 and 35 hp.; one scarifier; one disk harrow; one 12-ft. power-lift road machine; one 12-ft. hand operated road machine; one 600-gal. feeder truck; one water pump; two $1\frac{1}{2}$-ton dump trucks; one 800-gal. distributor and one sheepsfoot roller.

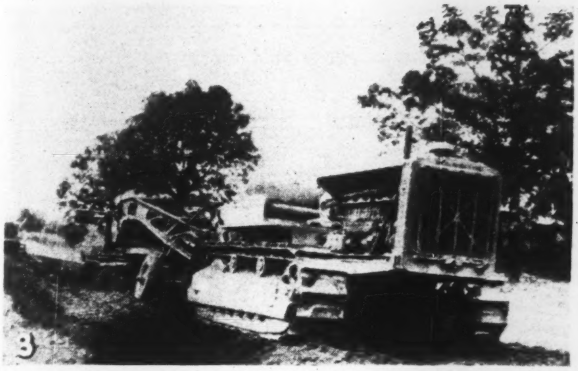
Compaction is the critical operation, and in commenting on this Mr. Mills points out that it is found that two sheepsfoot rollers speed up the work of compaction very considerably. After the sheepsfoot rollers have compacted the soil as much as practicable, there is usually a mulch of loose soil varying in thickness from 0 to $1\frac{1}{2}$ in. depending on the type of soil. This top mulch is compacted with loaded trucks or pneumatic tired rollers. Considerable dif-



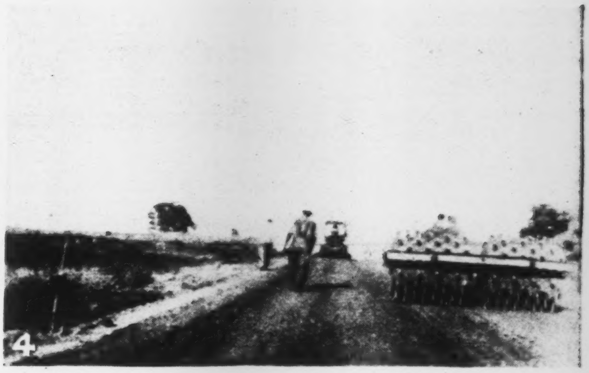
INITIAL MIXING



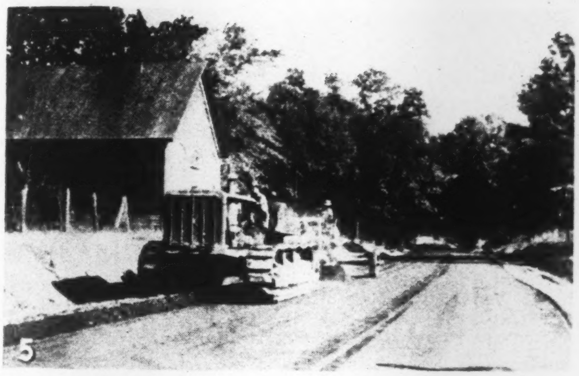
APPLYING WATER



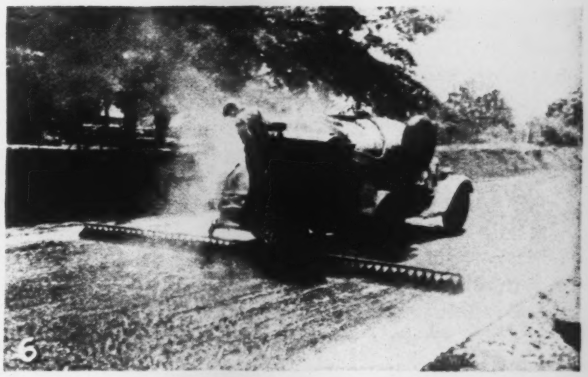
MIXING TAR AND SOIL



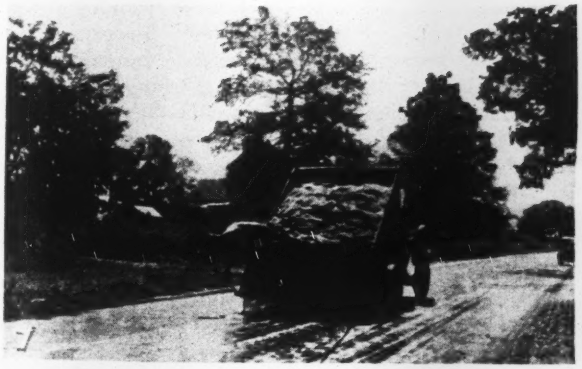
COMPACTING MIXTURE



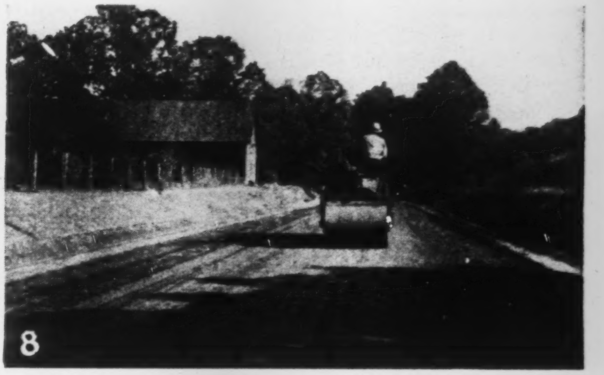
FINISHING BASE



APPLYING TACK COAT



SANDING TACK COAT



ROLLING SAND COVER

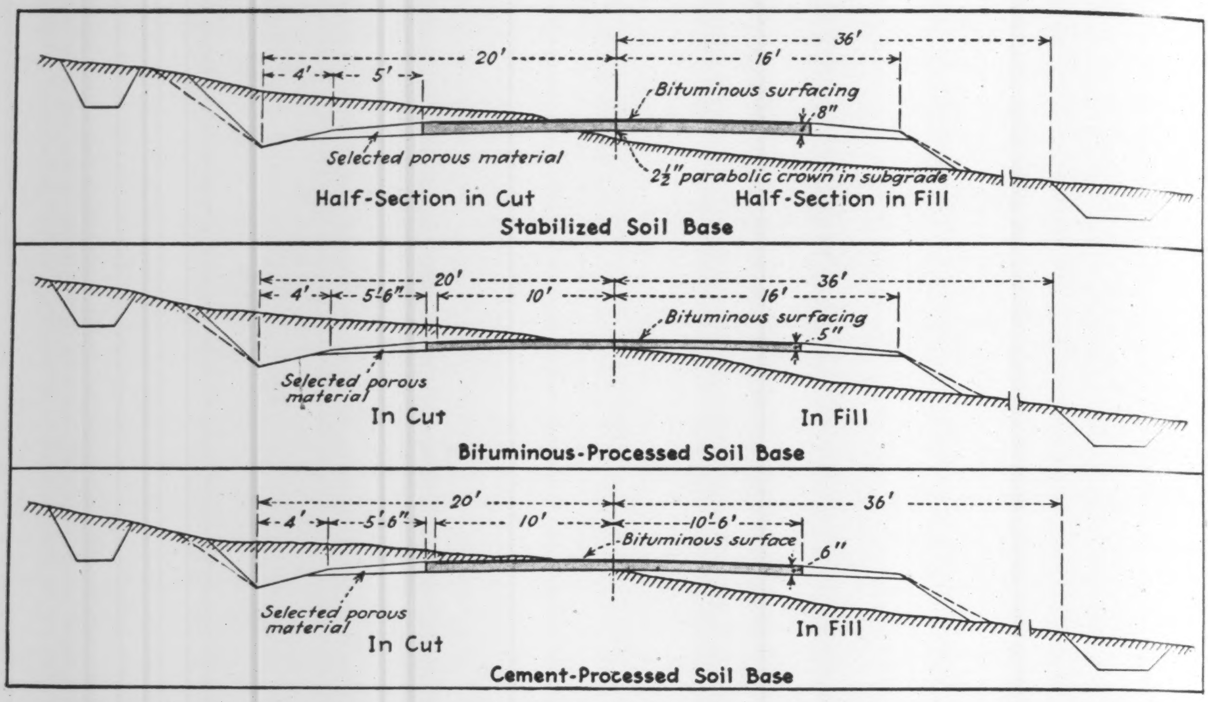


Fig. 3. Typical sections of stabilized earth and of tar and cement processed soil roads in South Carolina.

ficulty has been experienced in properly bonding this material to the rest of the compacted base and, of course, a lack of bond or difference in density may cause scaling. However, in soils that are most likely to scale, it is found that the sheepsfoot roller will work to the surface so that the loose material can be economically bladed off and wasted. In the final compaction of the top mulch, it is sometimes necessary to apply additional water to the soil-tar mixtures due to excessive evaporation, and this must be very carefully controlled as shrinkage and scaling are very likely to occur if the moisture content of the top mulch materials is not uniform and varies considerably from the material underneath it.

It is a general practice to apply a tack coat of 0.25 gal. per sq. yd. of 25–35-viscosity tar immediately after the top mulch is compacted. This tends to prevent excess drying which results in shrinkage cracks if the mix is too wet or high in clay. In some instances this tack coat is covered immediately with sand and the road is opened to traffic. This procedure helps to prevent the formation of shrinkage cracks.

All of the tar stabilized bases constructed to date have been covered with one of the following types of surfacing applied on top of the tack coat: (1) A single application of hot asphalt and ¾-in. stone; (2) a mixed-in-place drag seal approximately ½-in. thick using sand and ½-in. stone and cut-back asphalt, and (3) an inverted penetration double bituminous surface treatment with 1¼-in. stone as the maximum size. At the present time either of these surfaces appears to be adequate, but it is probable that advantages will be discovered for one type with continued traffic.

An encouraging summary

As stated, both tar and cement processing have gone far enough in South Carolina to be reasonable bases for writing specifications, but in nowise do the department engineers consider that the end has been reached. Service under traffic has yet to be determined and laboratory tests that will predict field results must be developed. There has also to be determined moisture-density relations correlated to roller weights. But the observer comes away from a study of the experimental work only sketchily presented here with definite conviction of its constructive character.

The South Carolina highway department is commissioner governed with J. S. Williamson as chief engineer. Much of the experimentation described has been directed by W. H. Mills, testing engineer, and to him and Mr. Williamson the editor is indebted for the account here of some features of South Carolina earth roads. A concluding article next week will review earth roadwork in North Carolina.

• • •

Indiana Checking Snow-Fighting Equipment

SNOW PLOWS and other winter equipment are being serviced and checked over in Indiana by the State Highway Department. Nearly 500 snow plows and as many graders allocated (one to each 100 miles) among the 36 subdistricts of the state are being put in shape for emergency use. The equipment is massed in the north half of the state where snow, ice and sleet are more frequent than in the southern part of the state. Additional preparations of the maintenance crews is the stocking at hazardous curves and grades of several thousand yards of sand and cinders which will be mixed with calcium chloride or other chemicals.

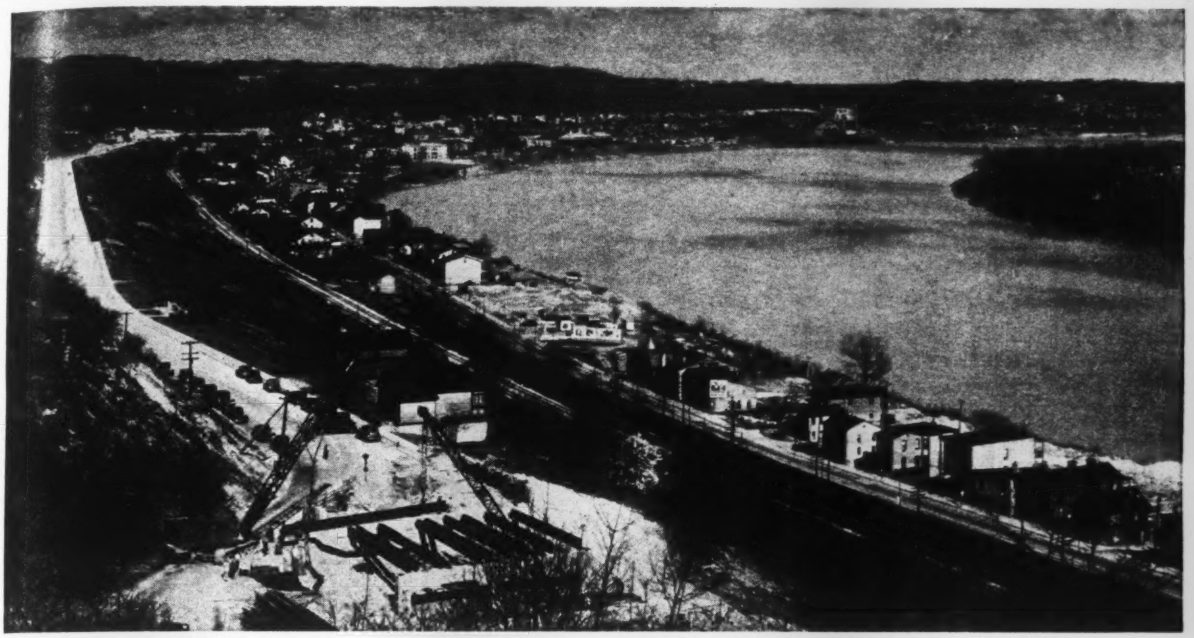


FIG. I. CINCINNATI'S NEW SUPERHIGHWAY ENTRANCE SKIRTS THE OHIO RIVER BLUFF FOR SEVEN MILES

A Scenic City Entrance Road

H. H. Kranz

City Engineer, Cincinnati, Ohio

Cincinnati is completing a high-speed entrance road seven miles long from the eastern suburbs of the city to its congested business center

In its new Columbia Parkway skirting the Ohio River for about seven miles, Cincinnati is completing one of the most striking of recent arterial city roads. With its variety of viaducts, half-viaducts, retaining walls, approach ramps and other structures, design and construction have been tasks of multitudinous detail that would require a volume to describe. In the article that follows, the author had set his limits at broad statements of the transport purposes of the road and of the principal structural elements that go to make up an $8,623,000 outlet from a traffic congested city business center.

—Editor

THIS MONTH Cincinnati motorists will travel for the first time the entire length of the new Columbia Parkway from the downtown section of the city to the furthermost eastern suburb, driving over a new high-speed highway of a total length of nearly seven miles. The completion of this Parkway will conclude more than a quarter of a century of suggestion and planning, and will furnish sorely-needed access to all of the populous eastern and northeastern suburbs. It is an accomplishment of which the city is proud.

Transport need served

Unlike many midwestern cities, which are extremely flat and level, Cincinnati occupies a number of hills, plateaus and valleys, the highlands being the residential areas, while the valleys are generally given over to the industries and the freight and passenger terminals of the five major railroads entering the city. The southern border of the city is the low water line of the Ohio River shore and the frontage along the Ohio is some 20 mi. with the business section located about at the midpoint of this frontage and about 1,000 ft. north of the river. The diagram plan Fig. 2 of the new highway indicates the geography.

As all of the suburbs of the city lie within a semicircle from 4 to 10 mi. north of the heart of the business section, the trunk highways serving these suburbs are all radial in character. Prior to the construction of the new parkway, travel to and from the eastern suburbs, which house a large percentage of the population of the city, used Eastern Ave. and certain sections of the Columbia Parkway, now being widened and relocated.

It was long ago generally conceded, even by that section of the

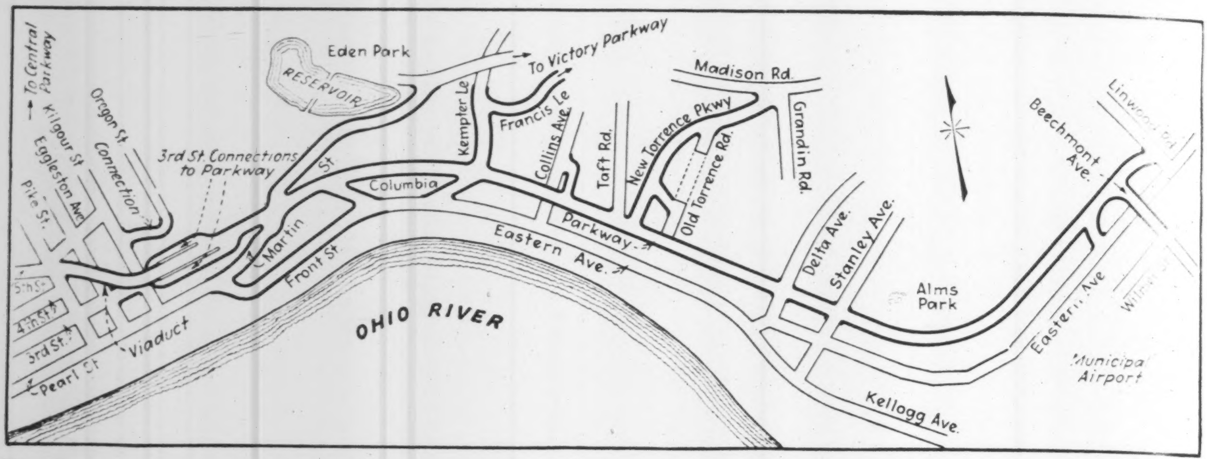

To Central Parkway
Kilgour St
Eggleston Ave
Pike St.
Oregon St
Connection
3rd St. Connections to Parkway
Eden Park
RESERVOIR
St
Columbia
Martin
Front St
5th St.
4th St.
3rd St.
Pearl St
Viaduct
OHIO RIVER
To Victory Parkway
Kempter Le
Francis Le
Collins Ave
Taft Rd.
New Torrence Pkwy
Old Torrence Rd.
Madison Rd.
Grandin Rd.
Parkway
Eastern Ave.
Delta Ave.
Stanley Ave.
Alms Park
Beechmont Ave.
Linwood Rd
Eastern Ave
Municipal Airport
Kellogg Ave.

Fig. 2. Location map of Columbia Parkway and connections, the new super-highway entrance to Cincinnati's business section.

population not affected, that arterial traffic facilities to the eastern and northeastern suburbs should be improved because of the large daily flow of traffic between these parts of the city and the business district. The parkway was therefore set up as a general project about 1928, and although there have been many changes in details, and minor changes in alignment, grade and type of construction, no major radical change has been made in the original general plan, except in the location of the viaduct entrance from the west as is noted later.

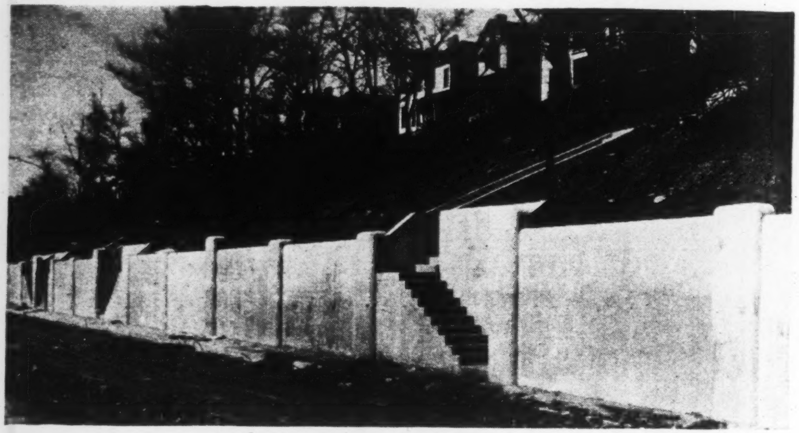


Fig. 4. A typical uphill retaining wall in the residence section between Taft Road and Delta Ave. (Fig. 2) showing general architectural treatment.

Progress was piecemeal

The first unit undertaken may be considered as being the grade crossing elimination of the Pennsylvania R.R. at Beechmont Ave. at the far eastern end, Fig. 2. This is a half clover-leaf affair, collecting the traffic of Linwood Road, Eastern Ave. and Columbia Parkway, and carrying it over Eastern Ave. and the railroad tracks. It was begun in February 1929 and completed in March 1931. Although Columbia Parkway existed only as a narrow macadam road at that time, provision was made in the crossing approach plans to connect to the new Parkway when it should replace Eastern Ave. as the main eastbound thoroughfare.

Another section undertaken at about the same time was between Kemper Lane and Taft Road (Fig. 2). Landslide difficulties encountered here, caused by fills placed along the sides of the hill, led to developing for future work a "notched in" type of construction, with a retaining wall, which has been used on all the other sections of the parkway where similar conditions were encountered. The work between Kemper Lane and Taft Road was begun in April 1929 and completed in October, 1930.

The third length of new road placed under contract was from the Beechmont overpass, some 7,000 ft. west. Begun in June 1931 and completed in October 1933, it utilized for the first time the "notched in" type of construction.

The last section completed prior to setting up the remainder of the work as a single unit, was the widening of the Fifth St. approach within the downtown area. As the property purchased for this widening was business frontage the cost of this section amounted to $1,900,434 with construction, plus the wrecking or remodeling of fifteen structures, amounting to $108,475, making a total of $2,000,909.

The existing street was 66 ft. wide and had a roadway 40 ft. wide; the strip of property purchased for the widening was 25 ft. wide entirely along the south side. The new roadway is 65 ft. wide and has two sidewalks each 13 ft. wide. The widening of Fifth St. was begun in June 1931, and completed in July 1934.

Final operations

The last unit, the subject of this article, included all the remainder of the work on the parkway as shown by Fig. 2. It extended between Pike Street and Stites Ave. and was set up as a single project, with contract limits determined only by convenience and to stimulate and assist local contractors in bidding on the various sections.

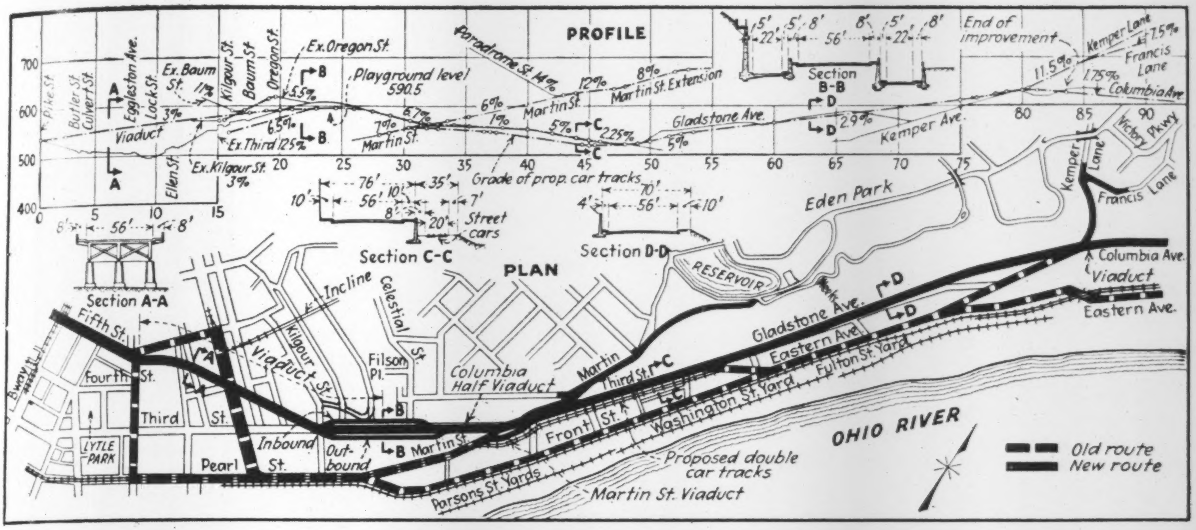

PROFILE
PLAN
700
600
500
400
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
Pike St.
Butler St.
Culvert St.
Eggleston Ave.
Lock St.
Ex. Baum St. 11%
Kilgour St.
Baum St.
Oregon St.
Ex. Oregon St.
5.5%
Playground level 590.5
Paradrome St. 14%
12%
8%
Martin St. Extension
6%
1%
Martin St.
6.7%
7%
Martin St.
5%
2.25%
Gladstone Ave.
5%
2.9%
Kemper Ave.
3%
Viaduct
6.5%
Ex. Third 12.5%
Ex. Kilgour St. 3%
Ellen St.
Grade of prop. car tracks
End of improvement
11.5%
Kemper Lane
7.5%
Francis Lane
1.75%
Columbia Ave.
A
B
C
D
Section A-A
8'
56'
8'
Section B-B
5'
5'
8'
8'
5'
8'
22'
56'
22'
Section C-C
76'
35'
10'
56'
10'
8'
7'
20'
Street cars
Section D-D
70'
4'
56'
10'
Fifth St.
Fourth St.
Third St.
Pearl St.
B'way
LYTLE PARK
Incline
Kilgour St.
Viaduct St.
Celestial St.
Filson Pl.
Columbia Half Viaduct
Inbound
Out-bound
Martin St.
Martin
Third St.
Front St.
Parsons St. Yards
Washington St. Yard
Eastern Ave.
Fulton St. Yard
Gladstone Ave.
Proposed double car tracks
Martin St. Viaduct
Eden Park
RESERVOIR
Kemper Lane
Victory Pkwy
Francis Lane
Columbia Ave. Viaduct
Eastern Ave.
OHIO RIVER
Old route
New route

Fig. 3. **Route of Columbia Parkway contrasted with the older Eastern Ave. route through its most difficult location from the business center to Kemper Lane.**

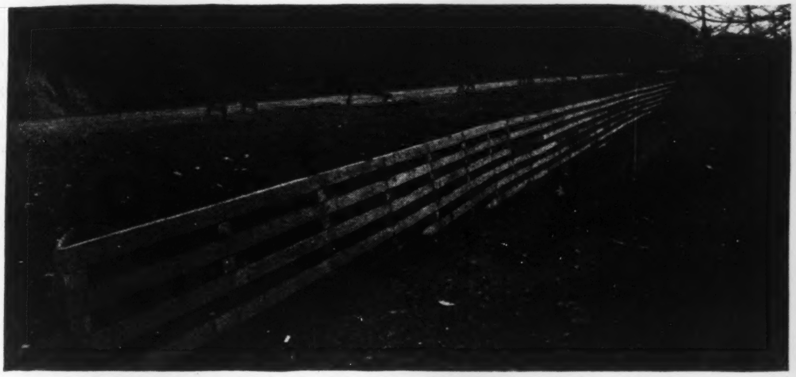


Fig. 5. **In less settled parts of the Taft Road-Delta Ave. section a large amount of concrete cribbing was used for downhill retaining wall.**

No problem of the entire project had more angles or received more consideration than the selection of the route between downtown and Kemper Lane (Fig. 3). Existing roadways were of old macadam or granite block, very narrow and crooked, and constantly choked with buses, trucks and street cars. Proposals advanced for this section included every type of complicated construction from tunnels to double deck viaducts, with a variation of cost from $3,000,000 to $9,000,000. The widening of Fifth St. between Main and Pike streets it was felt should carry some weight in the location of the west terminus and with this in mind a number of studies were made in the Division of Highways to select the most feasible plan within the limits of economy. An account of the plans considered would run too long.

Briefly, the scheme as adopted proposed a viaduct across the Eggleston Ave. valley in almost a direct line between the Fifth St. and Pike St. intersection, and Third and Kilgour streets. At the western terminus the viaduct curves around a large industrial building on a radius of 700 ft. At Kilgour St. the viaduct rounds into Third St. on a curve of 900 ft. radius. One-way connections to Third St. start at Kilgour St. and connect to the viaduct in the vicinity of Celestial St.

Beyond this point the route generally follows the line of old Third St. and Gladstone Ave., with cut-offs through new right-of-way where necessary. The main parkway throughout to Kemper Lane has a roadway 56 ft. wide, and roadway widths of 22 ft. on the Third St. connections and 36 ft. on the Martin Street connections. The knottiest problem was here—to work out a connection to bring in the upper and lower Martin St. to a proper line and grade. This viaduct work will be discussed in a second article.

East to Kemper Lane no intersections complicate construction which is of the notched in type. The wall along the north side of this section of the roadway varies from 8 to 12 ft. in height and is a modified T-type cantilever, designed for an infinite surcharge of 30 deg., with pressure being considered only above the midpoint of the shaft height.

The roadway of this section is 56 ft. wide, with a sidewalk space of 10 ft. on the south side, containing a cement sidewalk 5 ft. wide. The face of the wall is given the same architectural treatment as was given to all walls to the west, that is, large fluted pilasters 5 ft. wide at every expansion joint, and less prominent pilasters or posts, 3½ ft. wide, which are plain, at every intermediate butt construction joint.

Torrence parkway

East from Kemper Lane the first major operation is to provide access to Torrence Parkway, which, when completed, is expected to carry the heaviest traffic of any connecting artery feeding Columbia Parkway, as it provides a short cut to the city for a number of densly populated suburbs.

The proposed plan for Torrence Parkway illustrates the adaptation of existing topography to a major highway relocation a practice not often possible in municipal engineering. The old road nad a rather stiff grade and was very narrow. In addition, it entered Columbia Parkway at the top of a hill, and therefore was entirely unsuited to the new Parkway level, which was carried ahead on a straight grade through the hill, leaving old Torrence Road high and dry. A ravine located about 200 ft. to the west and meeting the parkway at the low point of the grade was therefore ideally suited for the new roadway relocation. This ravine extended almost the entire length between the terminals of the new parkway, and when a grade was developed it was possible to limit it to a maximum of 8 per cent without excessive filling of the old ravine. The roadway for the new connection as now under contract is 40 ft. wide, with two sidewalk spaces of 10 ft. each.

Torrence Parkway is 3,300 ft. long, and on the basis of bid figures and estimated quantities will cost $133,000. Property costs amounted to $136,990, not including several tracts donated for park purposes by wealthy owners. Before construction on the new roadway could begin it was necessary to wreck eleven dwellings within the new right of way, costing an additional $2,000.

The last gap filled

An old macadam road about twenty feet in width and almost constantly in need of maintenance existed between Taft Road and Delta Ave. The completion of other sections of the parkway and the subsequent increase in traffic on this section made it imperative that the roadway be widened and improved. The new roadway has the same characteristics of the "notched in" type of construction already described except where certain of the fills are supported by crib walls. It is 7,400 ft. long and has a roadway width of 44 ft. The cost of construction is estimated at $396,000; with property expenditures amounting to $8,000, the total is $404,000.

Pre-cast concrete cribbing is used along the south side of this project to prevent fills from infringing on abutting property. A project is now under way to clear all the houses from the first tier of lots abutting the south side of the parkway to afford a view of the Ohio River. If this is done, motorists will have an unrestricted view of the river and the Kentucky Hills along that part of the route extending from the downtown terminus to Delta Ave., a distance of over six miles, making the parkway a riverside drive in actuality.

Future connections

The Columbia Parkway is more than amply designed to take care of present-day traffic, plus a percentage as a margin of safety. However, in the event the city should expand or increase in population to a marked degree within the suburbs served by the parkway, it will be possible, without any loss of the present construction, to increase the capacity of the feeder connections more than 100 per cent by certain additions.

The first would be the construction of an additional viaduct within Third Street, from Pike St. to Kilgour St. to serve the "Bottoms" or "Wholesale" district. The possibilities of a connection through Eden Park, via Martin Street extension, will be disregarded, as it probably would be unnecessary in the event of the construction of an alternate Victory Parkway connection further east. Such a connection would provide facilities for enormously increased traffic by the construction of an elaborate grade-separating structure, one feature of which would be a tunnel at the Victory Parkway end to eliminate left-hand turns. Similarly at the south end of the Torrence Parkway a ramp curving over the Columbia Parkway could easily be installed if stoppage at this intersection becomes serious due to left-hand turning movement. The north end of the Torrence Parkway could also be arranged to eliminate congestion at Madison Road by a tunnel underneath it, and a by-pass for through Madison Road traffic. All of these additional facilities could be provided within a cost limit of $3,100,000.

Quantities and costs

Summarized briefly, the total cost of the entire project is $8,623,000 of which $4,805,000 represents property obtained for right-of-way. To acquire this right-of-way it was necessary to purchase over 500 additional parcels of property and wreck some 340 dwellings. Total excavation necessary for all of the various sections amounted to 560,000 cu.yd., with 90,000 cu.yd. used as fill. Practically all of the pavement of both the parkway and connections is of reinforced concrete 9 in. thick with the total area to be laid, estimated at 235,000 sq.yd. To perform the construction work on the 17 sections of the parkway required the services of 24 general contractors and innumerable subcontractors.

Interesting and unique features required in construction included tube piling 110 ft. long, an L-type cantilever wall 44 ft. high, H-type piling used as structural columns for a flat slab viaduct structure, and massive concrete piers and bents to "ride out" superficial landslides, with complete utilization of waste excavation to construct new connections.

Construction work on the first unit of the parkway began February, 1929, with the contract work on the Beechmont Avenue grade crossing abolishment. All of the contracts may be roughly divided into two classifications, those completed as separate entities, and those completed as separate contracts within a blanket project partly financed by a grant from the Public Works Administration of the federal government. Construction work on the first group included five contracts, totaling $885,044, with property cost amounting to $2,808,294, making a total of $3,692,338. The second unit totals $4,930,368, with construction work amounting to $2,933,131 property $1,966,237, of which about $1,520,000 was contributed by the Public Works Administration. Operations on the first unit of the latter project began in January 1936.

Direction

All of the engineering work done in connection with the development of preliminary plans and the preparation and supervision of final contracts was carried out by the Division of Highways of Cincinnati. The earlier sections completed prior to 1932 were under the direction of H. F. Shipley, former highway engineer, who was also instrumental in developing the early preliminary plans for the remainder of the project. Upon his retirement, in 1932, the author became the head of the Division of Highways.

Determining Influence Lines By Balancing Angle Changes

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Combining joint balancing process with deflected load line axiom provides a simple procedure

SINCE PUBLISHING the method of balancing angle changes (*Proceedings*, A.S.C.E., September, 1936), the writer has concluded that one of its most effective uses is as a tool for the determination of influence lines. This use was suggested in the original paper but details were not presented. The increased importance of rigid frame structures in the bridge field, requiring a rapid and convenient method of obtaining influence lines, gives these details a current importance.

The use of moment distribution as a tool for influence line studies was first discussed by Cross and Morgan in "Continuous Frames of Reinforced Concrete," page 104, and was later presented as a general conception of influence values by the writer in Vol. II of "Theory of Modern Steel Structures," page 188. F. Kruys (*ENR*, Jan. 20, 1938, p. 112), has discussed two special applications of the method. Although moment distribution is a convenient tool for many analytical studies, as the writer has emphasized repeatedly, it seems that the method of balancing angle changes has several unique advantages in the study of influence lines for continuous structures.

Two distinctly different methods of determining influence lines are in common use. (1) A unit load may be moved across the structure and the value of a given stress function may be computed for each position of the load. From these laboriously derived data the designer then can plot an influence line for the chosen stress function. The deflected load line may be used, and is in fact, an influence line when the deflection is produced by a single unit distortion in the nature of the chosen stress function; for example, a unit angle change is produced at a point *A* if an influence line for moment at the point *A* is desired. This procedure forms the background of modern mechanical methods of analysis and of the most effective modern mathematical procedures.

In the method of obtaining influence lines by balancing angle changes we have, combined in one procedure, the convenience of the balancing process (performed upon angles instead of moments) and the refinement of the direct determination of the influence line from the deflected structure. As an illustration, consider the continuous beam of Fig. 1. For those who are not already familiar with the method of balancing angle changes, the following definitions will be necessary.

Definitions

Angle Change and Joint Rotation: An angle change ϕ_1 is a particular end slope, for example, the end slope of a simple beam. A joint rotation θ_C is the angle through which all members at the joint *C* rotate when an angle change, such as ϕ_1 at this joint, is eliminated by rotating member No. 1 and the joint in opposite directions. The joint rotation recorded is the end angle change, ϕ_1, times the joint-rotation factor for member No. 1 at the joint C.

Joint-Rotation Factor: This factor is $K_1 \ \Sigma K$ where K_1 is the stiffness factor or I/L value for the particular prismatic member No. 1, and ΣK is the combined stiffness of all members that meet at this joint.

Carry-Over Factor: When one end of a simple beam is rotated through a clockwise angle, the far end rotates through a counterclockwise angle one-half as great. Hence the carry-over factor for angle change is —0.5

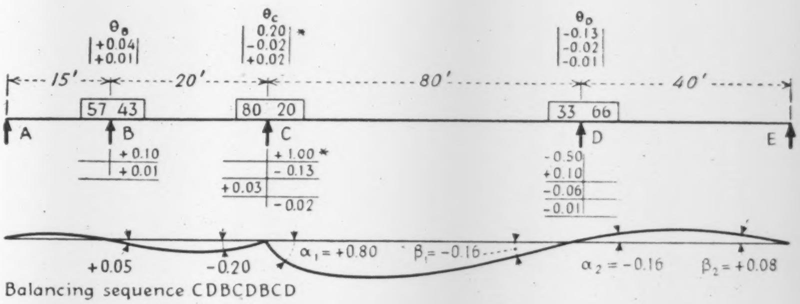


Fig. 1. Angle balance in a continuous beam for discontinuity at support at C.

The balancing procedure in Fig. 1 is for an angle of +100 at the end *C* of the member *CD* for the continuous beam *ABCDE*. This value is marked with an asterisk, and the same marking is used to indicate the joint rotation θ_C of —0.20 which this permanent angular discontinuity produces at the joint C when the external restraining moment is released. From this point on the balancing procedure is normal, that is, end angle changes or ϕ-values are multiplied by joint-rotation factors, as given in the boxes at each joint, to obtain joint rotations or θ values. The carry-over angle to the far end is 50 per cent of the actual rotation of the near end of the member. This rotation is the difference between ϕ and θ, or θ alone if there is no ϕ-value for the particular member under consideration. The balancing sequence used in Fig. 1 is *CDBCDBCD*, but other sequences are as satisfactory.

The final joint rotations found in Fig. 1 are 0.80 radian at the joint C, 0.16 radian at the joint D, and 0.08 radian at the joint E. The procedure is to be completed by computation of the deflections at the tenth points of the spans *CD* and *DE* as caused by these joint rotations.

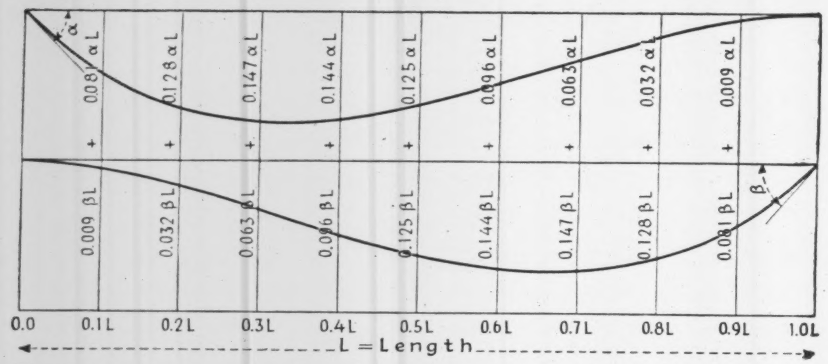
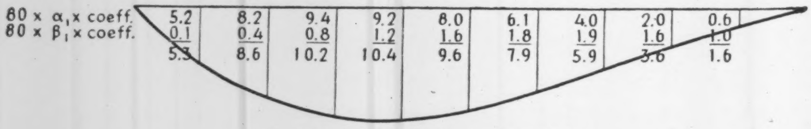
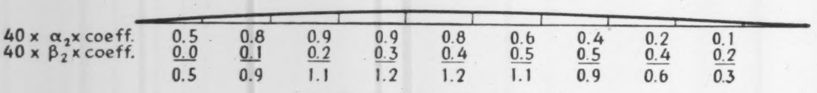


Fig. 2. Deflections in terms of end angle changes, α and β for a beam held fixed at one end.

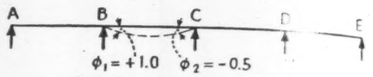


(a) Deflections in span CD

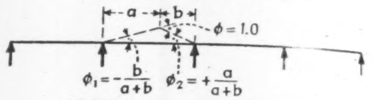


(b) Deflections in span DE

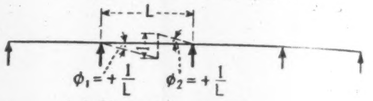
Fig. 3. Deflection computations for spans of four-span continuous beam shown in Fig. 1.



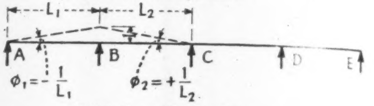
(a) Moment at support B



(b) Moment within span BC



(c) Shear in span BC



(d) Reaction at B

Fig. 4. Angle changes that give rise to influence lines for various stress functions.

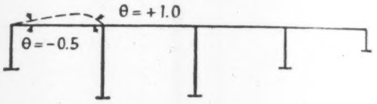


Fig. 5. Influence line determination affected by side lurch.

It is convenient to compute partial deflections as produced by each end rotation separately and then to combine such partial deflections. The law of superposition justifies the addition of such partial calculations for nearly all ordinary functions, such as stress, moment, shear, reaction, slope and deflection, but not for work. Fig. 2 shows the tenth-point deflections of a beam held fixed at the far end and rotated through an angle α at the left-hand end or β at the right-hand end. Since this deflected curve would be an influence line for moment at the rotated end of a fixed-end beam, the various tenth-point deflections can be computed as end moments in a fixed-end beam for a concentrated unit load at distances a and b from the ends of the beam, that is, Pab^2/L^2. Hence at the three-tenths point the deflection should be $(1.0 \times 0.3 \times 0.7^2 \div 1.0^2)\,\alpha L = 1.47\alpha L$. The coefficient at the seven-tenths point would correspondingly be $0.7 \times 0.3^2 = 0.63$. These and other coefficients can be computed mentally and checked with the curves of Fig. 2.

As soon as the end slopes of the span *CD* in Fig. 1 are known, each can then be used as a value of α or β in Fig. 2, and the resulting deflection curve will be as computed in Fig. 3a. The corresponding curve for the span *DE*, worked out by use of θ_D and θ_E, appears in Fig. 3b. Since these curves are parts of the deflected load line caused by a unit angular discontinuity introduced at the joint *C*, they represent those parts of the influence line for M_C corresponding to the spans *CD* and *DE*. It would be equally simple to complete the influence line by computing the deflections of the spans *AB* and *BC* from the corresponding θ values of Fig. 1.

Comparisons

It is interesting to compare the procedure described above with the corresponding procedure used in balancing moments wherein it is necessary to distribute a fixed-end moment for each end of each member, a total of six separate balances for the case of Fig. 1. In balancing angle changes the necessary information for determining a single influence line is obtained by a single-balance of one discontinuity of unity. From the joint rotations the corresponding deflections, which are the influence ordinates for bending moment, can be computed very simply without even the need for determining any bending moments in the spans. The method of balancing moments gives much more information than is needed for a single influence line, and therefore consumes more time than can be justified unless all moment influence lines are needed.

If a classical method of analysis is used, an even longer procedure may be necessary than by balancing moments. The cumbersome shifting of a unit load with repeated computation of M_C might conceivably be performed by area moments and the three-moment theorem, or preferably by the general method of indeterminate structures, but the work would be interminable. A better procedure than this would be to find the fixed-end moments corresponding to a unit angle change at *C*, to balance these fixed-end moments, and then to use area moments for the computation of the deflected load line. However, it is obvious that none of these procedures can compete favorably with the method of balancing angle changes, particularly when only one or two influence lines are needed.

The method of balancing angle changes is not limited to the determination of influence lines for moment, but is also convenient for computing influence ordinates for shear or reaction. The illustration in Fig. 4 shows how initial angle changes either resisted or unresisted can be introduced to start the balancing procedure. Where these angle changes are resisted, as in Fig. 4*a*, there is a joint rotation immediately produced, which is in the opposite direction to the resisted ϕ-value. Where the distortion is unresisted, as in *b* and *c* of Fig. 4, the internal angle changes that correspond to the unit distortion are not to be balanced but remain unchanged during the balancing process. End-of-span discontinuities in *b* and *c* of Fig. 4 will disappear during the procedure of balancing angles. In Fig. 4*d*, the discontinuities at *B* and *C* are to be eliminated.

Finally the method of balancing angle changes can be used for the determination of an influence line for a structure where side lurch occurs. Fig. 5 illustrates the introduction of a unit angular distortion to produce an influence line for moment in the girder at the second reaction point of a bent of four continuous spans. After the balancing of angles, it will be necessary to adjust shears by permitting side lurch until the total horizontal shear in the five columns adds up to zero. Then the deflected horizontal load line will represent the influence line for moment desired. With as many as five columns, however, the effect commonly is negligible.

Suggestions On Sludge Pumping

METHODS OF PROCEDURE in pumping primary sludge from separate sedimentation tanks to digesters, an important detail in the operation of sewage treatment works, were discussed at a meeting of Illinois plant operators and engineers of the State Department of Public Health, and the accompanying tabulation of records is taken from the quarterly "Digester" published by the department. At each plant a pumping schedule should be devised that will keep the primary tanks clean and yet minimize the amount of excess water discharged to the digesters with the raw sewage. Some of the conclusions arrived at are summarized below.

1. Insufficient or delayed pumpage of primary sludge allows digestion to start in the tank and results in large chunks coming to the surface. Too frequent or too much pumping puts excess water through the digester, resulting in waste of heat, interference with digestion, excessive amounts and poorer quality of supernatant, and thin digested sludge.

2. The best pumping schedule for each plant must be determined by trial. Many factors are involved, such as: type of settling tank, character of sewage, working hours, season of year, and kind of pumps. At Geneva, Ill. (see table), a plain hopper-bottom tank without mechanism is used. Where an operator is in attendance only during the day, it is common practice to pump sludge early in the morning and again in the late afternoon, but the length of pumping period varies widely.

3. Pumping rates of 35 to 50 g.p.m. appear most common, as there is no pulling of the sewage through the sludge blanket. But higher rates are reported satisfactory at Kankakee, Rockford, Elgin and Chicago Heights, where cross-collectors with flight-type mechanisms are employed. It is to be remembered that the rate of supernatant discharge is equal to the sludge pumping rate at plants having fixed-cover digesters. This is another reason for pumping slowly at such plants.

4. Center-scraper mechanisms are usually operated continuously, but flight mechanisms are frequently operated only 30 to 60 minutes before and during pumping. Where there are only two or three pumping periods daily, flight-type mechanisms should be operated sufficiently often and long to prevent "belching" chunks of sludge when the mechanisms are started.

5. Accurate sampling and detailed laboratory work on primary sludge is highly valuable, as such records make positive determination of digester loading possible, and can be used to explain digestion upsets.

Illinois Primary Sludge Pumping Data

				Aurora						
	Kankakee	**Rockford**	**Elgin**	**Single Stage**	**Two Stage**	**De Kalb**	**Chicago Heights**	**Geneva**	**Woodstock**	**Rochelle**
Type Treatment	Prim.	Prim.	Tr. Filt.	Tr. Filt.	Tr. Filt.	Tr. Filt.	Act. Sl.	Act. Sl.	Act. Sl.	Act. Sl.
Type Sewers	Comb.	Comb.	Comb.	Comb.	Comb.	Sep.	Sep.	Sep.	Sep.	Sep.
Population Served	22,300	85,000	37,000	49,000	49,000	8,300	22,800	5,000	5,600	3,785
Sewage Flow (m.g.d.)	2.3	10.1	4.3	6.6	5.9	1.2	2.0	0.8	0.9	0.34
Primary Sludge										
Type Settling Tank Mech	Flight	Flight	Flight	Center Scraper	Center Scraper	Center Scraper	Flight	None	Flight	Flight
Total Gallons Daily	8,000	33,900	4,750	20,600	20,000	4,000	5,500	5,130	3,400	5,400
Gal. per capita daily	0.36	0.39	....	0.42	0.41	0.48	0.20	1.03	0.61	1.42
Gal. per m.g. Sewage	3,480	3,350	....	3,120	3,400	3,330	2,750	6,410	3,780	15,880
Pumping Rate (g.p.m.)	74	120	150	40	40	35	100	100	40	90
No. Pumpings Daily	10	12	3	5	5	5	8–9	2	2–3	2
Ave. Pumping Time (minutes)	10	22	10.5	103	96	15–60	5–10	25	40	30
Percent Total Solids	7.5	6.2	4.1	3.6	3.6	....	3.5	2.1	....	2.1
Percent Volatile	63.2	73.7	71.3	65.2	69.2	60.0	69.0	76.8	....	78.6
Sludge Digestion										
No. of Stages	1	2	1	1	2	1	1	1	1	1
Digest. Vol.— (c.f. per cap.)	1.9	1.2	....	2.5	2.5	2.7	4.75	4.1	3.0	3.0
Storage Vol.— (c.f. per cap.)	1.9	2.75	0	0	0	2.6	4.75	0	0	0
Digestion Temp.— (F.°)	98	85–90	89	84	84	85–90	90–96	71	85	85
Gas Prod. (c.f. per cap.)	1.06	1.35	0.96	0.93	1.10	1.3	0.79	1.42	1.05	1.77
Gas Prod. (c.f. per lb. vol.)	7.3	8.9	10.2	10.0	13.0	7.9	15.8	9.0	....	9.0
Solids (%) in Supernatant	0.5	0.5	0.1	0.4	0.4	0.3	....	0.5	....	0.2
Solids (%) to Drying Beds	8.5	9–10	5.5	6.6	5.7	8.5	7.1	7.1	3.3	2.1
Solids (%) Transfer Sludge	....	5.2	....	....	2.9	....	....	....	....	....

Notes on Sewage Disposal

A monthly summary of current developments conducted by Willem Rudolfs

PAPER WASTE TREATMENT—The well known Save-all process for the removal and recovery of fibers and fillers from paper wastes is capable of retaining considerable quantities of settleable and suspended solids, producing an effluent containing from 50 to 100 p.p.m. total suspended material. About 3 years ago Karlström (Sweden) introduced the flotation process where the suspended solids in the effluent vary from 30 to 50 p.p.m. The liquor coming from the paper machine is flocculated with caustic soda and milk of lime and then mixed with a resin glue solution while it is vigorously aerated. The finely divided suspended particles are buoyed up and removed by suction. The slurry is returned to the machine, and the purified water can be used as make-up water or discharged into the stream. No fungi or slime-forming bacteria develop. Pedersen (Norway) has developed a similar flotation process without vacuum removal of the slurry. In one of the most important paper mills in Finland instead of lye and lime, a glue is used for coagulation and foaming. Use of the highly colloidal bone glue (developed by the Norwegian, Sveen) results in an effluent, which according to Sucksdorff (*Finnish Paper Journal*) contains only 12 to 20 p.p.m. total suspended solids.

COPPER POISONS SLUDGE—The effect of poisonous wastes on sludge digestion has been reported from time to time on the basis of laboratory experiments and plant operation. Inorganic poisonous wastes seem to be more detrimental than organic poisons. The difficulties encountered at Menden and Neheim in Germany have been reported by Prüss (*Ann. Report.* Ruhrverband, 1936). The copper content of the sludge in Menden was so great that no gasification took place; sludge in the digestor contained from 1.5 to 2 per cent of copper on a dry basis. The only possible way to eliminate such difficulties is to have wastes pre-treated by the contributing industry before discharge into the sewer.

CLEANING FILTERS—Growth of weeds on sand filters and the spread of algae and fungi on trickling filters may cause considerable pooling and clogging. A unique method of weeding sand filters was reported by Lautenschlager (*11th Report*, Ohio Sew. Conf., 1937). He has developed a gadget which consists essentially of a blade of sheet steel about 30 in. long, sharpened on one edge and mounted on a handle. This blade, held at the proper elevation, is drawn through the sand at a depth of about 1 in. below the surface and serves to cut off and destroy weeds very rapidly.

Experiences in controlling growths and pooling on trickling filters at Akron where flooding is not practical was described by Harroun. By using a spike-tooth harrow for scratching the surface of the filters the sloughing of filter growths is materially hastened and this prevents pooling. No clogging of the lower part of the beds results, since the material passes readily through the filters and results in gradual unloading instead of the discharge of large masses of material at certain times of the year. Harrowing of trickling filters has been practiced at other places with rather good results.

EFFECT OF GAS LIQUOR ON TRICKLING FILTERS — Intermittent quantities of gas liquors received at a treatment plant affect performance, especially where trickling filters are used. Many experiments have been made to remove the ammonia from the liquor before reaching the plant, and results obtained at Harrowgate, where the gas liquor is evenly discharged into the sewer, are of considerable interest. Oliver (*The Surveyor* Apr. 22, 1938) describes two filter units of the same dimensions, constructed on a scale to the works plant, comprising balancing tanks, settling tanks and trickling filters. One unit received the percentage of gas liquor to be dealt with, while the other treated ordinary sewage. The filter distributors were of the rotary type. After several months operation the oxygen consumed and nitrate values of the unit without gas liquor averaged 5.1 and 16 p.p.m. while the sewage with gas liquor showed an average of 8.8 p.p.m. oxygen consumed and 24 p.p.m. nitrates. In actual practice with approximately the same percentage of gas liquor (.03 per cent) the results were even more favorable.

GAS FOR FUEL—Sludge gas is successfully used for heating purposes, for driving engines, and for auxiliary fuel in incineration processes. Alert to the possibilities of further uses Sperry (7th *Annual Report* Aurora San. Dist. 1937) tells of experiences with sludge gas in a portable gasoline engine and pump during construction operations. Without change of type of sparkplugs, compression or magneto, the gasoline engine performed well on sludge gas. Garden hose was used to convey gas from a nearby plant. The engine driven pump unwatered trenches for a period of 4 months and this arrangement saved the cost of several hundreds of gallons of gasoline. The gas produced at the Aurora plant amounts to about 10 cu.ft. per pound volatile matter, and its use during 1937 was distributed as follows: 34.1 per cent for heating digesters, buildings and laboratory; 38.8 per cent for pumping engines, 14.5 per cent for incinerator purposes and the remainder wasted. The use of gas for driving prime movers saves the District over $5,000 a year; the engines paid for themselves in 26 months of operation.

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Blue Ridge Parkway

THE construction program for the 480-mile Blue Ridge Parkway has progressed so that a 140-mile unit in Virginia and North Carolina will be opened to traffic by next spring. Grading and drainage on 55 miles of the parkway in Virginia have been completed and surfacing contracts are now under way.

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